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Systems Theory Based Framework for Competency Models

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SYSTEMS THEORY BASED FRAMEWORK FOR COMPETENCY MODELS

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ABSTRACT

SYSTEMS THEORY BASED FRAMEWORK FOR COMPETENCY MODELS

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The purpose of this research was to develop and apply a systems theoretic framework for design, analysis and transformation of competency models using an inductive research design. This research examines the origins and development of competency models from a systems theoretic perspective. Competency models have been largely developed by a comparative method first proposed by McClelland, or the use of Delphi method survey techniques. The assumption that a population containing an exemplar and fully successful members would enable population of a holistic competency model has reported numerous failures. Similarly, reporting on the use of Delphi methods has focused on attempting to refine or augment Delphi methods to fill gaps in the competency models that are already in use. Rothwell and Lindholm called for methods that will reduce the backward looking bias of current competency development models. The literature of systems theory is applied to the concept of competency models via inductive theory building using Whewell's Discoverer's Induction supported by the structure of grounded theory. A competency model framework was developed that represents a distillation and synthesis of systems theory literature. The resulting framework can be used to design, assess and transform new or existing competency

models. A single extant model was examined with the competency model framework revealing competency model inconsistencies that can be closed in a transformation effort.

This research represents a fundamentally new approach to the construction of competency models, focused on a theoretical outlook rather than the dominant pragmatic approaches in use today. Additionally, the use of Discoverer's Induction as the methodology in conjunction with the methods of grounded theory represents a methodological contribution to theory building due to the rarity of the combination.

This dissertation is dedicated to the proposition that when you start to think something is missing from what everyone else accepts as correct, go ahead and explore that idea and see where it leads you. You might find something interesting. I certainly did.

ACKNOWLEDGMENTS

In one's life, there are many people who in large and small ways contribute to one's successes. My parents made a large contribution by instilling in me a life-long desire to learn, test limits, and try new things. I follow their examples as they watch over this effort from the starry night above. My devoted wife has supported my efforts in so many ways, from encouragement to start and determining how to manage this expedition financially, to proofing my many papers, including this one. I could not have gotten this far without her help and encouragement.

I extend many, many thanks to my chair for his patience and hours of guidance on my research and editing of this manuscript. I also thank the committee other members that allowed me to explore such interesting concepts, even when they might be unfamiliar or different from the expected.

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PREFACE

As I began the journey that is my doctoral studies, the dissertation loomed in the distant future. Imagined to be an almost insurmountable hurdle, it was indistinct yet formidable. As the formal study phase went rapidly by, the need to at least settle on a topic became more pressing, while shedding little light on the dissertation itself. The formal class phase illuminated that I was evolving. Previously, a firm adherent of positivist science, the recognition that people are a much more interesting problem was awakening the insight there are other perspectives to approach the larger problems of engineering, business and society.

My experiences as senior naval officer, consultant, and civil servant had repeatedly demonstrated the capability of those hard sciences to overcome or solve daunting technical problems, yet the social aspects appeared unsolved, even unsolvable. Finally, research topic selection and definition entered my personal critical chain. It was no longer avoidable, yet what to study, what to research? Five possible topics were investigated, yet none survived the questions of any doctoral work: Was it executable in a reasonable window? Was it original? Was it significant? All five topics failed one or more of the questions and giving up looked like the only way out.

Then, a review of a project for a client pointed out, once again, the deep, recurrent problem: how does the organization hire, train, develop, select for promotion, or separate its personnel? This question ultimately determines the success or failure, if not the survival of each organization. My experience was that something was wrong with how almost every organization that I've been a member of dealt with this problem. Problems

were both in execution (what some call "theory of use") and conception (could be called espoused theory). My initial forays into the literature only confirmed my fears – organizations screwed up what they did, and there was the strong possibility that the whole structure of what they did was flawed.

The literature had numerous examples of tweaks, (i.e., minor improvements to how competency models execute), while rethinking the underlying structure was a rarity; so rare that I recognized that there was a gap. This idea grew into an exploration of how such gaps are filled and a realization that the hypothetico – deductive approach could likely not generate a new theory of competency models. A qualitative approach was required: but which one? The search took me all the way back to Francis Bacon and William Whewell. Whewell's Discoverer's Induction was a methodology ideally conceived for generating new theory, but it lacked the mechanics to handle the vast literature I was considering using as the basis for a new framework of competency models. Then, along came grounded theory, a modern method with assistive software and a robust literature on how to apply the method to my task.

The road now lay open, and the basic structure of the dissertation was forming. That structure is as follows: Chapter 1 introduces the problem, not only my perspective, but the perspective of other, more skilled and experienced leaders like Eberhard Rechtin. These perspectives drive the purpose of the study. This chapter also translates those concerns into formal research questions while making clear the limitations and the delimitations of this exploratory research. The significance of such contribution wraps up chapter 1 and sets the transition to chapter 2. In chapter 2, the literature of competency models is explored from their origins, through evolutionary development to the current

tinkering with improvements. The recognition of experts in the competency field of shortcomings in their models is a useful bridge to the research design; however, there is one stop in the literature in another field, project management, where a challenge was issued by Koskela to rethink the field from the ground up. This comports with my own assessment of competency models, we need to start from the ground and build up. This perspective, rethinking competency models from the ground up is the motivation of the majority of chapter 3, research methodology. I saw a way to not be anchored by what had gone before, to be free from all I had learned conducting the literature review, and to be open to a new frontier. Discoverer's Induction offered that window, but lacked sufficient detail at the method level. It did offer enough clarity that confirmation would be required, i.e., a face validation, or in other words, a case study. The methodology for the case study is included in chapter 3. As noted earlier, grounded theory kept turning up during the competency literature review. To me, this was a completely new concept. But grounded theory offered the same promise as Discoverer's Induction: creating new theory from a collection of facts. Chapter 4 describes the details of that process. It begins with the literature data search which divides the literature into data elements which are then somewhat organized by the open coding but needing a new, different structure. Axial coding begins the development of that structure, the reorganization of the data elements into a new shape. I held no preconceived notion of the final framework, but began to see several different possibilities. Each pass through the data, each comparison of what was still in the framework changed the structure of the framework. Finally, as selective coding proceeded, the final shape took form. Oriented by two axes, the framework includes perspectives of time, leadership and performance. It fascinates me that those

categories, despite never being search terms, thrust themselves to the fore. Then there was the case study, real-life cross-checked with the literature. Numerous organizations have competency models, but almost every organization contacted was searching for some missing ingredient. Winnowing to one organization made the case study manageable and leaves significant room for future research.

Chapter 5 reports the framework and the results of the case study. At least for today, we have an answer for both of the research questions. And we have ammunition for Chapter 6, the implications and future research. And there are lots of potential future research ideas, which is not a bad result for such an indeterminate, amorphous object when I first started.

This preface was a joy to write, conceived on a stormy, fall day. The remainder of this document is more formal, but almost as carefully constructed. Please enjoy and I hope it will help you on your own search for improved competency models and better organization results.

1. INTRODUCTION

Why do some organizations thrive, and some always seem to struggle? Why don't I know what kind of day I am going to have when I come to work? How come some of my people seem to be able to do anything and others struggle to do the most basic tasks? These are some of the questions that I had on a daily basis regardless of the organization I worked in. It turns out that I am not alone in these questions. Amongst others, Eberhard Rechtin had similar questions:

> When I first came to USC I came with a question from fellow CEO's 'WHY is it that, although we have created and recreated the finest engineers, managers and scientists in the world, and although we have created some of the finest world-class, memorable projects (and some of the greatest disasters as well) we can't tell ahead of time whether they will be glorious successes OR terrible failures?' (Valerdi et al., 2008, p. 5)

These questions have driven my search for answers on how to improve organizational performance and guided my exploration for a better way to develop competency models.

While it is clear that there is no single silver bullet, one of the key elements for improving organizational performance is the selection, training, mentoring and assessment of the organization's people. Over the past 30 years, many organizations have adopted competency models as the core of how they select, train, mentor, and assess their people. While some organizations have seen performance improvements with the implementation and use of competency models, this has not been uniform, and there are

many reported instances of failure even in organizations that believed they had robust competency models. Competency models have been developed with a reductionist comparative worldview as their core theme. Few models appear to have been developed from a holistic, systems theory based perspective. My perspective is developing a competency model framework from systems theory that results in a more holistic, adaptive competency model.

Competency models have a variety of meanings. The definition that will be used to guide this research was best explicated by Rothwell and Lindholm as:

> The result of competency identification. A competency model is usually a narrative description of job competencies for an identifiable group, such as a job category, a department or an occupation. It contains key characteristics that distinguish exemplary (best-in-class) performers from fully-successful performers. (Rothwell & Lindholm, 1999, p. 91)

Competencies become the foundation of a company's human capital plan. Returning to Rothwell and Lindholm:

> Capabilities represent the skills, abilities, and expertise within an organization. They describe what an organization is able to do, and how it is able to do that. Capabilities are thus associated with groups of individual competencies that collectively turn into organizational competence. Traditionally, a firm's competitive advantage is developed from financial or economics capability, strategic or marketing capability and technological capability. (Rothwell & Lindholm, 1999, p. 96)

This chapter introduces the proposed research beginning with the purpose of the study, the research questions, and a discussion of the intent of each question. The chapter ends with a discussion of the significance of the research, the contributions to knowledge and an outline of the limitations and delimitations of the study.

1.1 PURPOSE OF THE STUDY

The purpose of this research is to develop and apply a competency model framework for analysis of competency models from a systems theoretic perspective. Competencies first arose as a response to gaps in the use of aptitude testing to select personnel (McClelland, 1973). The first competency model was the product of a comparative survey of a large number of managers over a five year period. The focus was comparative - those differences that distinguish exemplary and fully successful managers (Rothwell & Lindholm, 1999). That comparative perspective has continued from the beginning of competency development - a thrust toward comparing superb performance to merely successful performance and capturing the perceived differences. That comparative perspective results in a largely backward looking and case based science. Organizations are routinely flummoxed by the arrival of problems, often well heralded, that derails the organization's performance and require extended time to develop the competencies to craft and execute successful approaches to those problems. Driven from a set of axioms and propositions, a holistic perspective may reveal a better way to look at competencies.

1.2 GUIDING QUESTIONS

Systems theory offers a set of axioms and propositions, a set that appears aligned with the complex problems that bedevil organizational leaders today. This research sets out to inductively develop, based on that fundamental set of axioms and propositions, a competency model framework designed from systems theory.

To satisfy the purpose of the study and to enable answering the following research question, the research builds upon that set of axioms and propositions that are an existing foundation of systems theory to enable answering the following research question:

What framework can be developed for the analysis of competency models from a systems theory perspective?

The research uses inductive theory building to develop a competency model framework. The competency model framework was developed based on the literature data search, grounded theory and the inductive method known as *Discoverer's Induction.* The framework is a conceptual model that can be used for the development of competency models to enhance organization performance. The framework is not a tool or method, that is a step-by-step procedure, but a model that can serve as a guide for the development of competency models grounded in systems theory. The ultimate goal was to produce a competency model framework that is transportable as well as generalizable by articulating systems propositions within the competency model body of knowledge. The competency model framework is grounded in systems theory rather than based on comparative analysis of exemplars and fully performing professionals.

The second part of the research is to validate the inductively built competency model framework on an actual real world competency model by answering the following question:

What results from application of the systems theoretic competency model framework to analyze a competency model in an operational setting?

This principal output of the case study is to produce a face validation of the competency model framework. This portion of the research is centered on analytic analysis of the case study data. The structure for the research is presented in Figure 1.

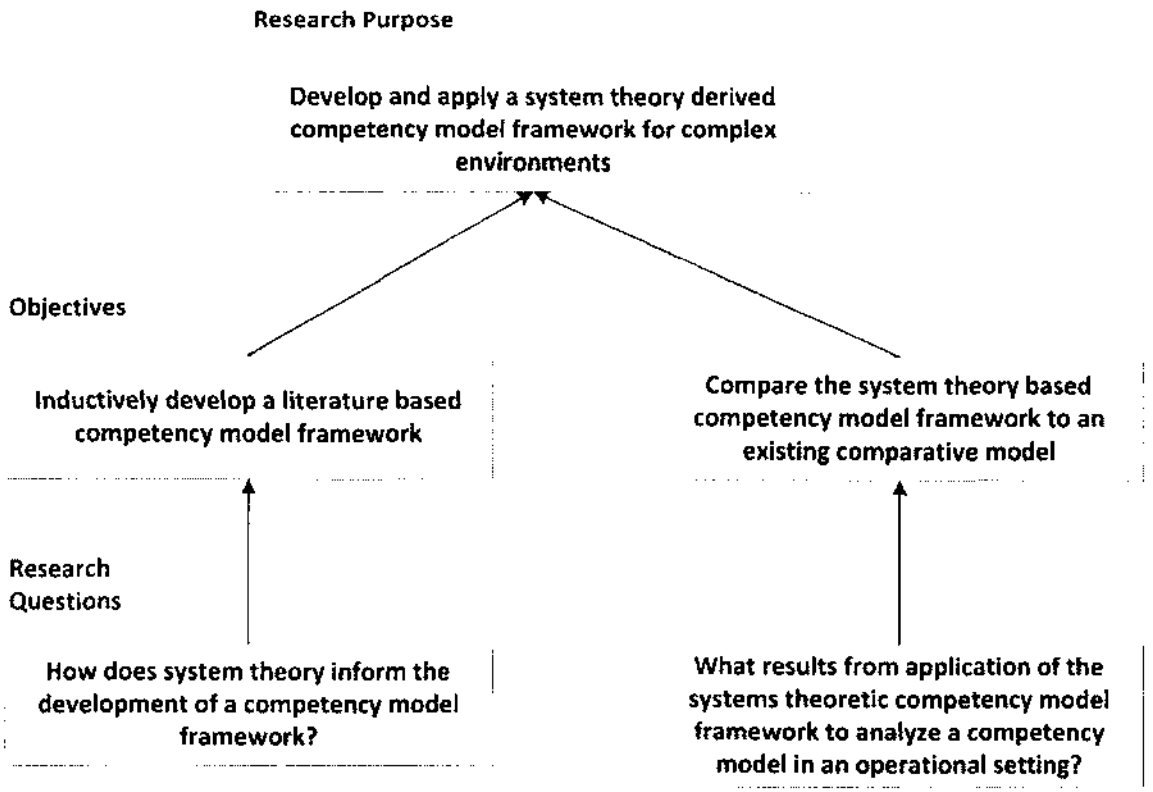


Figure 1: Structure for Inquiry

1.3 STUDY LIMITATIONS AND DELIMITATIONS

An examination of the limitations and delimitations early in this discussion is helpful. Three limitations are discussed 1) the use of inductive theory building, 2) the use of case study methods and, 3) the generalizability of case study methods. The delimitations help the reader to understand what is not included in the research design.

1.3.1 LIMITATIONS

An inductive research design was used to develop the competency model framework. As will be discussed in Chapter 3, there are challenges to inductive methods of theory building. The inductive research design is structured to include elements that improve the theoretic validity of the results. This research includes a case study examination of the existing competency model using the new competency model framework developed herein. The use of case studies has often been challenged as a weak research design. In chapter 3 and 4 there is are extended discussion of case study design and execution, including steps taken by this researcher as part of the research method to ensure compliance with the Canons of Science.

The case study is an examination of a single competency model and thus it may not generalize well. While the case study has been carefully selected with the intention of delivering analytic generation discussed by Yin, the actual case study may prove to be generalizable only within organizations similar to the case study organization.

1.3.2 DELIMITATIONS

While this research is framed within the competency model literature it does not develop a specific competency model, but rather develop a competency model framework that would allow practitioners in the field to either create a new competency model or examine an existing competency model from the perspectives contained within the competency model framework. The development of the holistic systems theory based competency model framework uses an inductive theory building method; this research only tested the competency model framework on one case.

1.4 RESEARCH SIGNIFICANCE

The research contributes one methodological element to practicing competency design professionals via the development and application of the framework. The framework provides a wholly new method by which competency designers can apply systems theory propositions to the construction and management of competency models. An additional methodological contribution is developed by the use of Whewell's Discover's Induction as an overarching methodology with the specific methods of grounded theory.

Practitioners in organizations that have already developed competency models are now able to construct a competency model independent of their previous methods. They are now also able to assess or transform existing competency models using the new framework. The case study serves as a model of how to apply the competency model framework to an extant competency model.

2. LITERATURE REVIEW

The purpose of the literature review is three fold, similar to the structure of the review itself. The first purpose is to examine the origins, development and challenges of competency models and the associated theory are examined in the first portion of the literature review. It highlights the creation of competency models, how competency models have evolved over the decades, and what forces have driven that evolution. The second purpose is an examination of the weaknesses and gaps in current competency models. The third purpose is an examination of the current research in closing those gaps. The exposition of those shortfalls in current research efforts concludes the literature review and makes clear the opportunities for this research. One of the gaps in the literature is the lack of an appropriate theoretical basis for the existing competency models. The objectives are to establish the need for this research and avenues that have already been explored in the field.

2.1 LITERATURE RESEARCH SCHEME

The literature research schema has two significant components. The first is the traditional role for the literature review. It examines the origins and foundations of competency design, the theory of competency design, the practice of competency design and use, and the weaknesses identified by both academic and practitioners in the field. This phase of the literature review seeks to understand the methodological approaches taken in the field of competency design and identify the weaknesses or gaps in competency design theory. This phase also uncovers the approaches taken by other researchers to address those weaknesses or gaps. The second component of the literature review is synthesis. The synthesis of this literature review phase ensured that the research

questions were properly framed. Figure 2 depicts the literature review schema and how the wide body of knowledge was narrowed to support the development of a generalizable competency model framework.

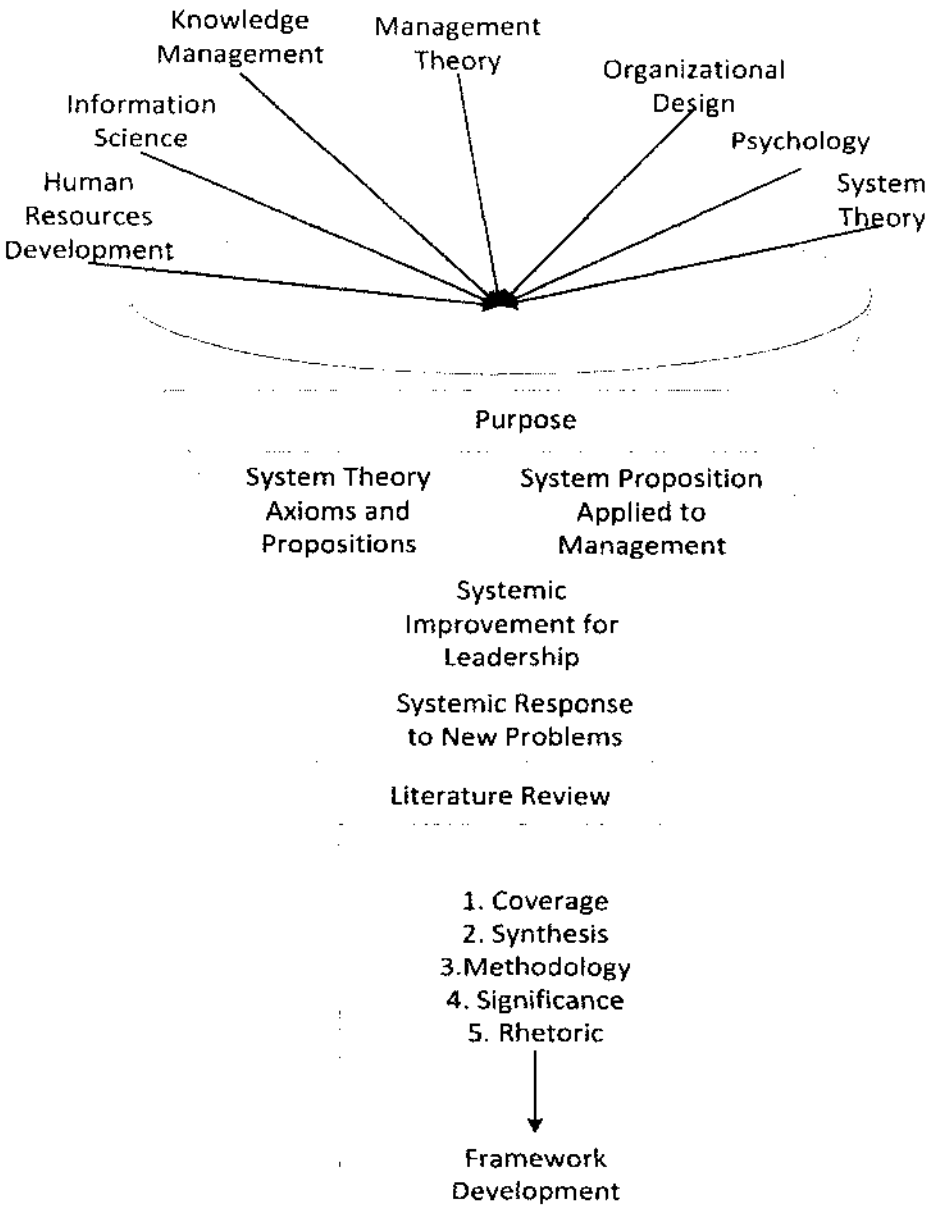


Figure 2: Literature Review Schema

2.2 BREADTH OF LITERATURE REVIEW

The literature review includes scholarly journals in fields associated with the research purpose and research questions. As depicted in Figure 2 above, the sources for this review are from a wide variety of disciplines. To provide additional clarity, Table 1 depicts scholarly journals representing the disciplines as depicted in Figure 2. The literature review was conducted as depicted in Figure 3, drawn from an engineering report developed for prior academic work (Akers et al., 2011).

Table 1: Scholarly Journals in Literature Review

Discipline	Journal Title	ISSN	Article Retrieval Source
Dissertations	*Doctoral Dissertations*	N/A	Digital Dissertations
Human Resources	*Advances in Developing Human Resources*	1552-3055	Sage Journals Online
Human Resources	*Review of Public Personnel Administration*	1552-759X	Sage Journals Online
Human Resources	*International Journal of Training and Development*	1468-2419	Business Source Complete (EBSCO)
Information Science	*Communications of the ACM*	0001-0782	ACM Digital Library - Magazines
Information Science	*Decision Sciences*	0011-7315	ABI/INFORM Global (Proquest)
Information Science	*Decision Support Systems*	0167-9236	Science Direct
Information Science	*Information and Management*	0378-7206	Science Direct
Information Science	*Journal of the ACM (JACM)*	0004-5411	ACM Digital Library, Journals
Knowledge Management	*Electronic Journal of Knowledge Management*	1479-4411	Open Access Journals
Management	*Academy of Management Journal*	0001-4273	Business Source Complete (EBSCO)
Management	*Academy of Management Review*	0363-7425	Business Source Complete (EBSCO)
Management	*Engineering Management Review (IEEE)*	0360-8581	IEEE Xplore
Management	*European Business Review*	0955-534X	Emerald Management
Management	*European Management Journal*	0263-2373	Science Direct
Management	*European Journal of Operational Research*	0377-2217	Science Direct
Management	*Harvard Business Review*	0017-8012	Business Source Complete (EBSCO)
Management	*Journal of General Management*	0306-3070	Business Source Complete (EBSCO)
Management	*Journal of Operations Management*	0272-6963	Science Direct
Management	*Journal of Management*	1557-1211	Sage Journals Online

Table 1: Scholarly Journals in Literature Review (cont)

Discipline	Journal Title	ISSN	Article Retrieval Source
Management	*Journal of Management Information Systems*	0742-1222	Business Source Complete (EBSCO)
Management	*Management Science*	0025-1909	Business Source Complete (EBSCO)
Organization Design	*Organization Studies*	1741-3044	Sage Journals Online
Organization Design	*Journal of Organizational Behavior*	0894-3796	Wiley Online Journals
Psychology	*American Behavioral Science*	1552-3381	Sage Journals Online
Psychology	*American Psychologist*	0003-066X	APA Psycnet
Psychology	*Journal of Business and Psychology*	1573-353X	Business Source Complete (EBSCO)
Systems	*Emergence: Complexity and Organization*	1521-3250	Business Source Complete (EBSCO)
Systems	*Complexity*	1076-2787	Business Source Complete (EBSCO)
Systems	*Journal of the Operational Research Society*	0160-5682	JSTOR
Systems	*Journal of Systems and Software (Robert Glass)*	0164-1212	Science Direct
Systems	*Kybernetes: The International Journal of Systems & Cybernetics*	0368-492X	Emerald Fulltext
Systems	*Systems Research and Behavioral Science (Michael Jackson)*	1092-7026	ABI/INFORM Global (Proquest)
Systems	*Systemic Practice and Action Research (Robert Flood)*	1094-429X	ABI/INFORM Global (Proquest)

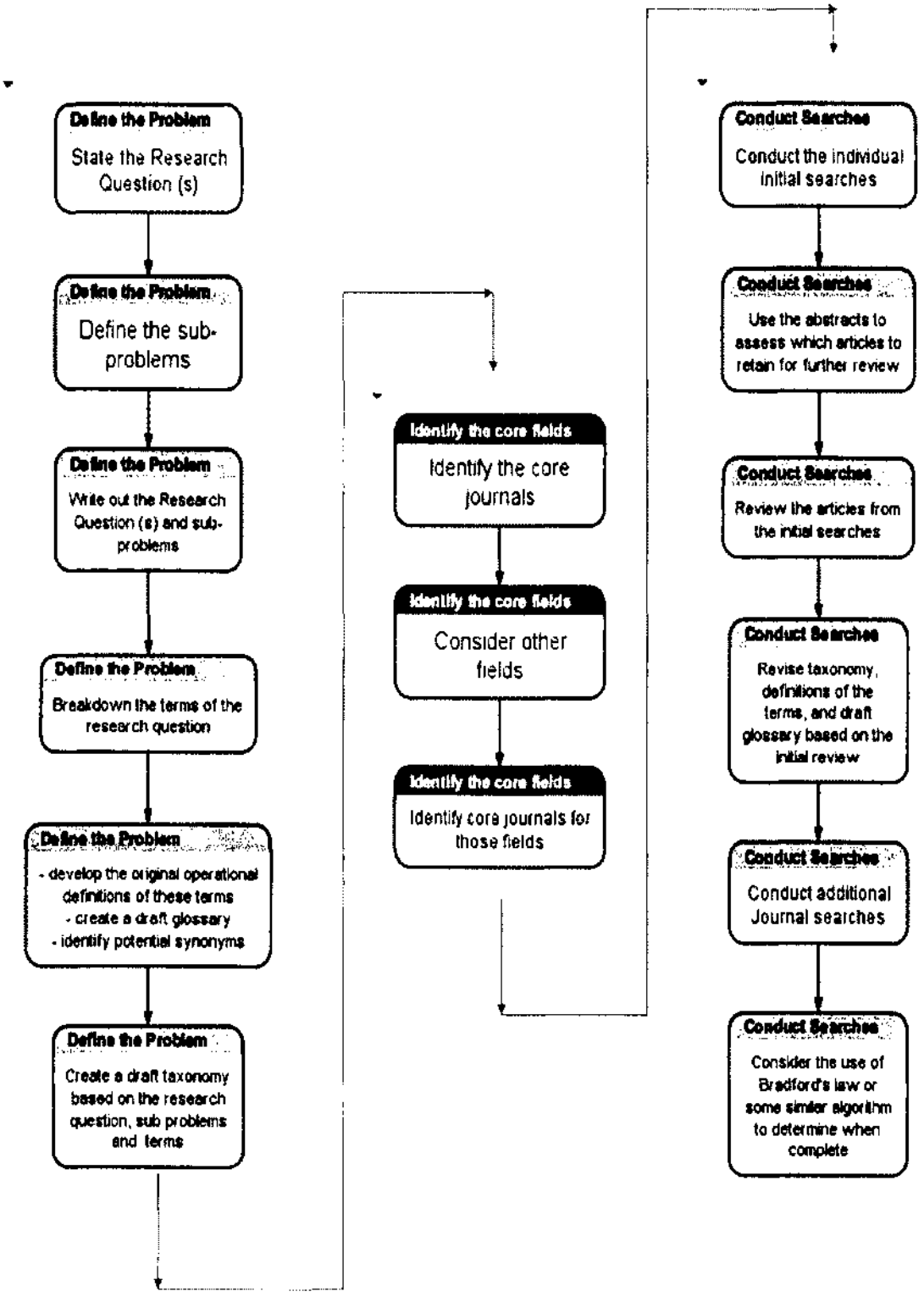


Figure 3: Literature Review Process

2.3 COMPETENCY MODEL LITERATURE SEARCH

The competency literature search was directed towards answering several questions: (1) Do competency models have an underlying systems theoretic basis? (2) Are there problems noted in the existing competency model literature? (3) Is there a viable approach already being examined to resolve the problems identified in the competency model literature? and (4) Does that approach seem likely to significantly improve competency models?

2.3.1 COMPETENCY MODEL DEVELOPMENT

Competency models began with a simple set of questions. Those questions led to a chain of inquiry, exploration, and development that puts us at today's state of competency models. The questions that were asked are:

> Why should intelligence or aptitude tests have all this power? What justifies the use of such tests in selecting applicants for college entrance or jobs? On what assumptions is the success of the movement based? They deserve careful examination before we go on rather blindly promoting the use of tests as instruments of power over the lives of many Americans. (McClelland, 1973, p. 1)

With these simple questions and an axiological assertion of improving the lives of many Americans, McClelland launched the concept of competency as the measure to make crucial decisions like hiring and promotion. His recommendation was simple "The best testing is criterion sampling" (McClelland, 1973, p. 7). He later addressed the difficulty of competence testing, relating it to the experience of intelligence testing.

> Criterion sampling, in short, involves both theory and practice. It requires real sophistication. Early testers knew how to do it better than later testers because they had not become so caught up in the ingrown world of "intelligence" tests that simply were validated against each other (McClelland, 1973, p. 7).

An early effort by McClelland to develop a competency model was with the US Navy. This effort was within the context of improving race relations during the turbulence of the 1970s. McClelland developed a model with eight competencies that would help the Navy improve its race relations. Importantly, McClelland pointed out to the Navy that there were insufficient people with those competencies, but that the competencies were teachable, which he set out to do (Oravis, 1982). At about the same time period, McClelland worked with the Army to develop a competency model for Organizational Behavior consultants. The model for development of the competencies was described by McClelland:

> Our idea was that in order to discover competencies, ideally we'd be like flies on the wall watching these guys perform every day. Since that wasn't practical, we decided to make them give us detailed, blow-by-blow accounts of certain critical incidents. We were like investigative reporters. We got accounts from fifty people of three episodes in which they had done their jobs very well and three in which they had flubbed. It was always harder for them to remember the flubs. When they came up with an episode, we'd walk them through it, demanding very specific details: what was the date, where were you, who else was there, what did you say, and so on.

> Once we had this mass of what we called behavioral event interviews, we analyzed them very carefully and asked ourselves what competencies these stars had shown that the other people failed to show. We were able to distill a distinct set of competencies which set them apart. (Oravis, 1982, p. 38)

By the early 1980s, the method first developed by McClelland was well established and being replicated on larger scales. McLagan and Bedrick conducted a large scale competency model development for the American Society of Training and Development (ASTD). The study:

> reviewed past research for lists of knowledges, skills, abilities, tasks and outputs that were then rationally clustered into competency areas. Role experts edited, added and deleted competencies, then rated the criticality and level of expertise required of each competency for their assigned roles. (McLagan & Bedrick, 1983, p. 12)

The implications for the long-term strategic advantages implied by a well-developed and executed competency strategy were soon being explored. Lado and Wilson examined both sides of the coin – firms that appeared to execute competency management well, and those that appeared to be inhibited by poor competency management (Lado & Wilson, 1994).

The methodology developed by McClelland and described by McLagan and Bedrick was developed as a pragmatic approach, but only weakly connected to an underlying theoretical foundation. Boyatzis and Kolb describe a similar approach, but one specifically tied to experiential learning theory (Boyatzis & Kolb, 1995). While

"many of the findings were consistent with the underlying framework, not all of them were..." (Ragothaman, Lavin, & Davies, 2007, p. 14).

Concurrent with the development of the perspective of competence as a characteristic of the individual that needed to be identified, trained, and used as a basis for promotion, Prahalad and Hamel were espousing the idea of *core competencies*, that is, organizational strengths that can be leveraged to provide lasting competitive advantage (Prahalad & Hamel, 1990). Prahalad summarized his idea as: "Core competency results when firms learn to harmonize multiple technologies" (Prahalad, 1993, p. 45). Discussing potential confusion with *capabilities*, he notes that capabilities are required for the organization to remain in business, but do not confer an advantage against other firms.

Within a short period time, the connection between individuals' competencies and the core competencies required for strategic advantage elevated the importance of competency management (Horney & Koonce, 1996). However, the elevated corporate interest in competencies also brought forward increasing numbers of problems with competencies. These included poorly executed competency studies. They were poor for a variety of reasons: (1) focused too narrowly on a specific job title, (2) ignoring one of the three cognitive, psychomotor or affective components of learning, (3) not including major components of the job, (4) not measurable and (5) including components that cannot be improved by training and development (S. B. Parry, 1996).

Researchers and practitioners alike struggled with the definition of the term competency. Hoffman surveyed the field and described three common definitions: (1) observable performance, (2) the standard or quality of the outcome of the person's

performance, or (3) the underlying attributes of the person. Hoffman noted that the first definition references observable performances or outputs of the learning processes. The focus is on accrediting the performer as competent. He describes the second definition as referencing a standard against which the outcome is measured. The use of standards is viewed as more flexible in tying competencies to needed organizational results. Hoffman discusses the third definition as focused on the inputs needed for competence. This may arise in situations where the output or outcomes are more complex and it becomes very difficult to describe competences as outputs or conformance to a standard. Hoffman develops a typology based on whether the competency model is output focused or input focused and whether it has individual or corporate uses. In the output focused environment, "competencies are outputs in the sense that they are performed as a consequence of training or other learning programs (T. Hoffmann, 1999, p. 280)". In the input focused environment, "[i]nputs refer to the content of the training and education needed by learners in order to become competent performers (T. Hoffmann, 1999, p. 280)". Hoffman concludes with a discussion of the confusion over the meaning of competency and defines the unifying concept as an effort to "improve human performance at work (T. Hoffmann, 1999, p. 285)."

Rothwell and Lindholm, writing at the same time as Hoffman, are far more aggressive in treating the competency field, issuing several challenges to the community. Beginning with a series of challenging questions, and providing definitions of competency, competency model and other important terms, Rothwell and Lindholm rapidly march through a history of competency from McClelland's groundbreaking work, McLagan's introduction of competency models as the "focal point for planning,

organizing, integrating, and improving human resource management systems" (Rothwell & Lindholm, 1999, p. 93). They note how

> Boyatzis conceptualized competency identification in a way that goes deeper than observed behaviors that can be reproduced through training. When management style is defined as a set of skills, attributes or characteristics of a manager, the concept refers to a pattern of behavior that the manager demonstrated and the values that he or she embodies. Boyatzis' model of managerial competencies is presented as a complex six-level dynamic interaction between the individual performing the job and his or her environment. (Rothwell & Lindholm, 1999, p. 94)

Rothwell and Lindholm describe the three most common methodologies used to create competency models: (1) the borrowed approach, (2) the borrowed-and-tailored approach and (3) the tailored approach. The borrowed approach has the benefits of being easiest and least costly to implement. Its biggest drawback is the lack of any methodological element to confirm that the model is actually useful given the organization's corporate culture. The borrowed-and-tailored approach requires only the modification of the borrowed model to be suitable for the new and unique corporate culture performing the borrowing. Methodology requirements are simplified compared to tailoring.

The tailored approach is the most rigorous and is suggested when the organization intends to use the model for selecting, terminating or promoting individuals. Five tailored approaches are laid out by Rockwell and Lindholm: (1) the process-driven approach, (2) the outputs-driven approach, (3) the invented approach, (4) the trends-driven approach

and (5) the work responsibilities-driven approach (Rothwell & Lindholm, 1999). While the specific steps and the focus of each of the five processes differs, all depend on some group of people coming up with a list of characteristics which can include behaviors, job outputs, work activities and personal characteristics that distinguish exemplars and fully successful performers. A duly constituted group of experts, who may be exemplars, supervisors, or consultants, examines the lists providing rankings and ratings. A process is selected to add, remove, modify and collate the characteristics that are then translated to competencies.

Rothwell and Lindholm examine the future of competencies and find that they will likely grow in use. Competencies offer greater explanatory power than job-based approaches. Competency models also address more than what people do, and "include the attitudes, feelings and motivation levels of exemplar performers" (Rothwell & Lindholm, 1999, p. 103). However, they point out three specific challenges: "(1) the ambiguity of terms and definitions, (2) past-oriented competency models and (3) issues involving the time-rigour tradeoff" (Rothwell & Lindholm, 1999, p. 103).

The challenges expressed by Rothwell and Lindholm have been taken up by a number of authors; however, none appear to have questioned the competency model approach from an underlying theoretical perspective. Competency model practice developed in response to weaknesses in the link between intelligence testing practice and job performance (McClelland, 1973; Rothwell & Lindholm, 1999). Competencies do not appear to be founded in theory, and have largely evolved in response to gaps in performance (Calhoun, Ramiah, Weist, & Shortell, 2008; D. J. Campbell, 2008; R. H. Campbell, 2006; Rothwell & Lindholm, 1999). Addressing the field of instructional

system design, D. Campbell (2008) noted the existence of a performance gap in competency models due to the evolution of the field to e-learning. Campbell developed a new competency model for the occupation using Delphi techniques and content analysis. Similarly, Calhoun, Ramiah. Weist and Shortell (2008) developed a competency model for a Masters of Public Health program using a modified Delphi technique. Calhoun has a comparatively robust element for *systems thinking* comprising nine elements in the final competency model. This is one of broadest systems thinking (or systems theory) selection of elements discovered in the literature. However, the model remains the fundamental structure of starting with a list and using experts to refine and order the listed elements.

Many authors seek to use specific cases to expand the inventories of required competencies (Squires, Wade, Dominick, & Gelosh, 2011; Stedman, 2012; Torres, 2009). Further, many organizations find that their framework does not anticipate future problems and leaves them without the requisite competencies to deal with the emerging problem until it has engulfed the organization's leadership and becomes an existential threat. Squires, et al.(2011), recall Hollenbeck, Morgan and Silzer's exchange of a series of letters challenging the value of leadership competency models (Hollenbeck, McCall Jr, & Silzer, 2006). Invoking work done by Vroom (2000) who reaches all the way back to Tannenbaum and Schmidt (1958) and their seminal discussion of choosing a *leadership pattern*, Silzer points out some of the strengths and weaknesses of competency models in use. Traditional efforts have focused on the current problems and development of the capability to address those problems (Newhard, 2010; Oravis, 1982; S. B. Parry, 1996; Wood Jr, 2009; Xanthos, 2006). Infrequent references couple future problems to the current efforts to improve competency models (Hammer, Edwards, & Tapinos, 2011;

Kurz & Bartram, 2008; Seiler & Pfister, 2009). Several researchers have addressed the development of an approach using systems theory and its propositions to create a holistic foundation that enables organizations to develop capabilities (although neither uses the word *competency*) that are not case specific (Phillip Anderson, 1999; Espinosa, Harnden, & Walker, 2007), while others have used components of systems theory to explore approaches to a particular gap (Bernard, 2001; Clark, 2005; Stines, 2003; Torres, 2009). Espinosa, Harnden and Walker invoke numerous systems thinkers, especially Beer and von Foerster (1981) while exploring what they called *meta-systemic management*. Seeking sufficient requisite variety to manage the turbulence of modern organizations, they propose the use of Beer's Viable System Model for organization design, including management control systems that would, by implication, include competency models (Espinosa, et al., 2007).

No competency model was found that was constructed from an independently derived set of axioms and propositions appropriate for the organizational system at hand. Development of a complete model independent of particular people (exemplars and fully successful) and attempting to extract differences between exemplars and fully successful people has rarely been reported. Additions to competency models based on a single systems theory principle or small set based on systems theory have been reported. Ronn (2011) focused on *complexity* as a competency element in leadership development. Van der Walt also focused on *complexity* as a key addition to competency models for leaders (Van der Walt, 2010). Shrivastava used the model of *open systems* to develop a competency model with only three elements focused on "managing interfaces, growth, and contingencies" (Shrivastava, 2008, p. 2) Stines used a holistic perspective,

borrowing "from systems theory and cybernetics (first and second order.)" (Stines, 2003, p. vii) He focused on the concept of *segmentation*, a key element of strategy for the business to business market managers that were the subject of his study.

A review of the management theory literature revealed a number of researchers looking at competency models, systems theory and management theory. Prominent is Lari Koskela who has been exploring the stalled pace of innovation in construction management from an epistemological view. He posits that:

> These metaphysical assumptions tend to strongly influence how the subject of the inquiry or action is conceptualized. The thing-oriented view seems to lead to analytical decomposition, the requirement or assumption of certainty and an ahistorical approach. The process-oriented view is related to a holistic orientation, acknowledgement of uncertainty and to a historical and contextual approach. It can be argued that production is intrinsically a process oriented endeavour. However, an analysis of current conceptualizations and methods shows that it is the thing-oriented view on the world that has dominated the research and practice of production management. The resulting mismatch between the assumed nature and true nature of production has arguably led to major generic failures of production management.
>
> As a conclusion, it is contended that the discipline of production management has to seriously address the metaphysical issues confronting both practitioners and scholars." (Koskela & Kagioglou, 2005, p. 1)

Koskela has proposed that management, especially project management, should be re-examined from a flow perspective, vice the substance perspective that has dominated the literature and practice. He traces the problem to two reports funded respectively by the Ford Foundation and the Carnegie Foundation that indicted previous practice and influenced the development of management science and research (Koskela, 2011). Koskela details the influence of these reports and arrives at three conclusions:

> First, the 1959 reports on business education have failed, throughout, to give appropriate direction for management research; the outcomes have not passed the test of relevance. Second, in spite of extensive (although somewhat myopic) discussion on irrelevance in the management scholar community from circa 1980 onwards, not much movement towards rectifying the situation can be seen. Thirdly, judging by the way the social science turn in management science happened, and at the correctives suggested, it is plausible that the ousting of production from management science in 1959 has been one major contributing factor to irrelevance across managerial sub-disciplines. (Koskela, 2011, p. 9)

The influence of Koskela on this research will be discussed in the next section.

2.3.2 RELATIONSHIP OF THE LITERATURE TO THEORY AND PRACTICE

Throughout the literature, there is a theme that some key element is missing. This theme drove McClelland to initiate the idea of competency models, and Boyatzis, Kolb, Rothwell and others to identify gaps and proposed ways to close those gaps. It is not until we get to Koskela that it becomes clear that the gap may have been at the very dawn of

the competency models, when they were created by comparative methods independent of a systems theory or equivalent body of knowledge. The competency models were created by a practical approach to the skills problem, and while they clearly represented an improvement from the previous intelligence test models, they ultimately come to barriers that can only be incrementally attacked using the same approaches. To make a stepwise improvement, a fundamentally different approach is required. Informed by Koskela and Vrijhoef's (2000) invoking Taylor (1914) and practice in systems theory, the systems theory literature presents itself as a candidate body of literature to use to create a competency model framework with the possibility of achieving that step increase in organizational performance. Combined with the call from Koskela to rethink the discipline of project management from the epistemological perspectives, it seems like an appropriate time to apply systems theory to competency models in the management domain.

A depiction of the competency literature is contained in Figure 4. The researcher has designated seminal works, explorations in the field, explorations in related fields and papers that clearly challenge members of the field to some new perspective or some change in direction of activities in the field.

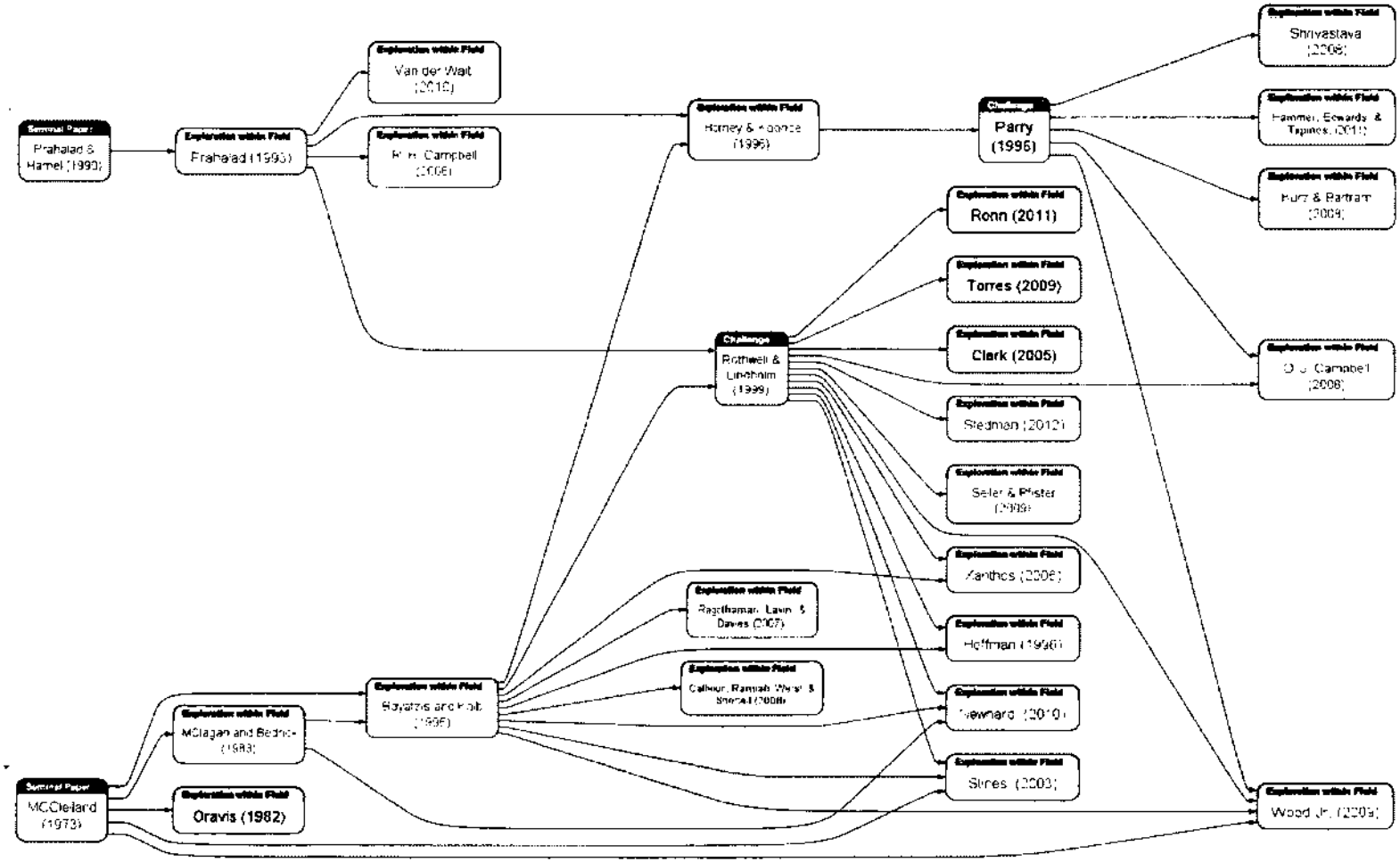


Figure 4: Pictorial Review of Competency Model Literature

2.4 SUMMARY OF COMPETENCY LITERATURE REVIEW

The literature review met its three objectives. The origins of competency models begin with the work of McClelland and his later associates demonstrate the evolution of the field. Prahalad and Hamel made the key contribution of translating individual competencies to organizational competencies. Several different methods of developing competencies have been explored in the literature, however, all contain a pragmatic bias with little theoretical underpinning. The weaknesses of competency models have been illustrated in the competency model literature along with recent efforts to close the gaps represented by those weaknesses. None have stepped back and asked if an underlying problem is the starting point, does there need to be a theoretical basis for competency models? That question forms the basis for the research at hand. This research represents an original method to identify, develop and use a competency model with a theoretical basis.

3. RESEARCH METHODOLOGY

This chapter examines the researcher's theoretical framework, perspectives, and ontological, epistemological, axiological and methodological views with the goal of explicating the chosen research methodologies. Making these views explicit assists in the reduction of bias and exposes hidden assumptions that might otherwise challenge the validity of the research. The purpose of this chapter is to introduce the research methodology. . Continuing from this vantage point, the selection of the literature for the theory building, the data collection strategy and the data analysis strategies are presented. The chapter continues with discussions of the appropriateness of grounded theory and criticisms of grounded theory. A definition of framework is created in anticipation of the final results, as well as a discussion of typologies and their construction. The second part of the research will include a case study. The potential sites are discussed, based on their characteristics and relationship to the domain for the competency model framework, the data collection strategies and analysis strategy for the case study. This chapter concludes with a discussion of the methods to improve validity and reliability.

3.1 THEORETICAL FRAMEWORK

Knowing where to start is essential in creating a research design – "the strategy, plan of action, process, or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes". (Crotty, 1998, p. 3) Crotty begins by suggesting two questions that must be answered: "First, what methodologies and methods will we be employing in the research we propose to do?

Second, how do we justify this choice and use of methodologies and methods?" (Crotty, 1998, p. 2)

Crotty discusses the relationship between the purposes of the research and the first two questions, which leads to an expanded set of four questions:

> "What methods do we propose to use?
>
> What methodology governs our choice and use of methods?
>
> What theoretical perspective lies behind the methodology in question?
>
> What epistemology informs this theoretical perspective?" (Crotty, 1998, p. 2)

These questions are answered over the course of this chapter and serve to enlighten the researcher as well as those that seek to follow him. The first step along this path is an examination of the research perspective. Having set the stage for the theoretical framework, the discussion now transitions to the research perspective and its implications for this research.

3.2 THE RESEARCH PERSPECTIVE

A depiction of the researcher's perspectives is contained in Figure 5, reflecting the different views informing that perspective. The researcher's perspective was formulated after review of Creswell's discussion on the interrelationships of philosophical worldviews, selected strategies of inquiry and research methods. This perspective is further tempered by Creswell's thoughts on selecting a research design. The research problem "needs to be understood because little research has been done on it" (Creswell, 2003, p. 18) and thus merits a qualitative approach.

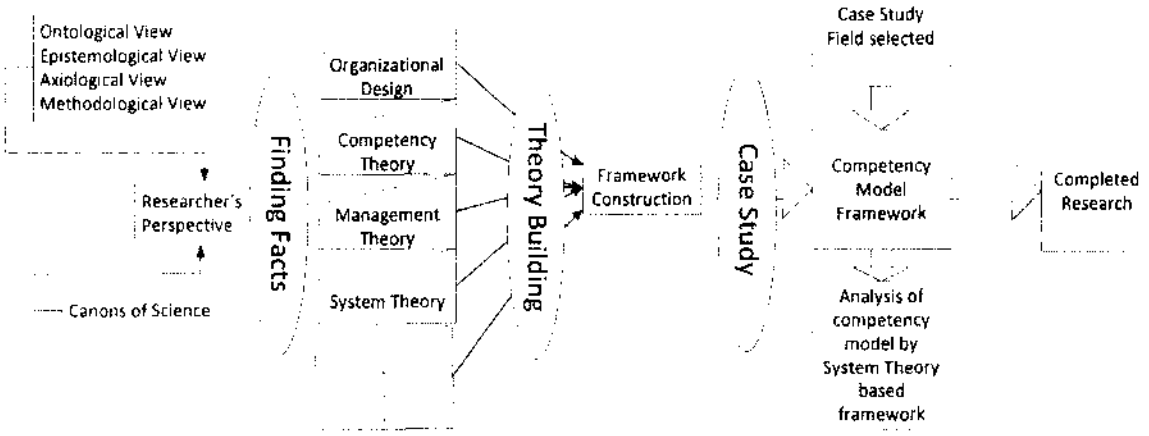


Figure 5: The Researcher's Perspective

The researcher's initial theoretical and philosophical perspectives that influence the researcher are the ontological and epistemological views that the researcher brings to the research.

3.2.1 ONTOLOGICAL VIEW

Ontology informs the theoretical perspective that lies behind the knowledge claims. "Ontology is the study of being." (Crotty, 1998, p. 10) While Crotty was driven by pragmatic concerns to not explicitly include ontology in his four column schema, the researcher has chosen to investigate ontological perspectives explicitly. Figure 6 is one view of the ontological perspective with wide usage that was developed by Morgan and Smircich (1980). It portrays a continuum between Idealism (the subjective school) and Realism (the objective school).

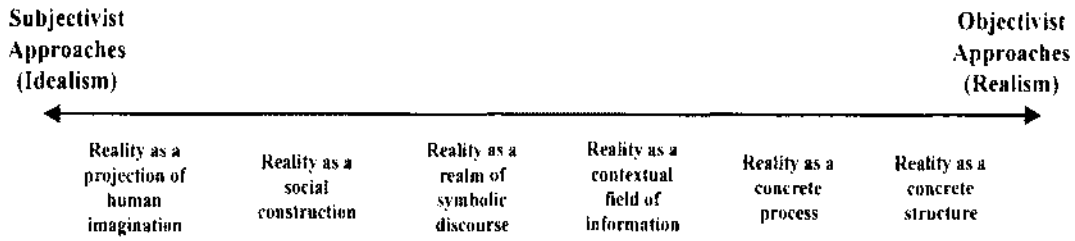


Figure 6: A Portrayal of an Ontological Continuum (adapted from (Morgan & Smircich, 1980))

The ontological continuum depicted in Figure 6 is a schema for exposing the assumptions that underlie the research method. Morgan and Smircich provide detailed descriptions of each perspective (Morgan & Smircich, 1980). They describe the social world as fluid with activity driven by the transmission of information and with relationships being relative rather than real or fixed. These descriptions align most closely with the researcher's assumptions for this research problem and are best described as *Reality as a contextual field of information.*

3.2.2 EPISTEMOLOGICAL VIEW

An epistemological view is developed for the research question, to serve as the foundation for selection of the research methodology. "In general, epistemological assumptions are concerned with the nature of knowledge and the proper methods of inquiry. By inquiry we mean the procedures or means by which we can obtain knowledge" (Iivari, Hirschheim, & Klein, 1998, p. 174). One depiction of the four major schools of thought and the major elements of each position are shown in Figure 7:

Positivism	Constructivism
Determination Reductionism Empirical observation and measurement Theory verification	Understanding Multiple participant meaning Social and historical construction Theory generation
Advocacy/Participatory	**Pragmatism**
Political Empowerment issue-oriented Collaborative Change-oriented	Consequences of actions Problem-centered Pluralistic Real-world practice oriented

Figure 7: Epistemological Schools of Thought (adapted from (Creswell, 2003, p. 6))

Creswell's depiction is helpful but not definitive. The framework building aspects of the research problem could be placed in either the Constructivist (theory generation) perspective, but connection to real-world practice forces consideration of a Pragmatic perspective. The point is that the choice of an epistemology is not entirely straightforward, but is an essential and interrelated part of the researcher's perspective. A key element is the academic discipline or area within which the research is being conducted or presented. An understanding of the epistemological positioning of the research and researcher, its applicability to the proposed research and associated data, and the degree of acceptance that the method will receive are elements of the selection process. The epistemological emphasis can also be overlaid on the ontological continuum developed earlier. Figure 8 is a depiction of the basic epistemological stances along the ontological continuum (Morgan & Smircich, 1980).

	Subjectivist Approaches (Idealism)					Objectivist Approaches (Realism)
Core Ontological Assumptions	Reality as a projection of human imagination	Reality as a social construction	Reality as a realm of symbolic discourse	Reality as a contextual field of information	Reality as a concrete process	Reality as a concrete structure
Core Epistemological Stance	To obtain penomenological insight, revelation	To understand how social reality is created	To understand patterns of symbolic discourse	To map contexts	To study systems, process, change	To conduct a positivist science

Figure 8: Continuum of Ontological Assumptions and Epistemological Stances (adapted from (Morgan & Smircich, 1980))

Because qualitative and mixed-methods research takes place in the natural setting, the researcher interacts with the participants of the research. "The qualitative researcher often goes to the site (home, office) of the participant to conduct the research. This enables the researcher to develop a level of detail about the individual or place and to be highly involved in actual experiences of the participants" (Creswell, 2003, p. 178). Morgan and Smircich provide insights into different epistemological stances, including terms that help the researcher align. Two descriptions bracket the researcher's perspective. While some merit is seen in viewing the world as concrete enough to focus on mapping processes and change, there is sufficient fluidity to the world, in the researcher's view, to suggest mapping contexts as a focus. The researcher relies on the concept of *and* to select an epistemological stance for this research problem that falls between mapping contexts and studying systems, process and change and thus can accomplish both, rather than neither. The combination of ontological assumption and epistemological stance are well placed for theory building and case study.

3.2.3 AXIOLOGICAL VIEW

Axiology refers to what we value or consider being right and is often referred to as ethics. Miles and Huberman (1984b) offer eleven ethical concerns to be considered by the researcher that span from the very *worthiness of the project* to the role of the researcher in the *use or misuse of the results.* These ethical concerns are (1) Worthiness of the Project, (2) Competence Boundaries, (3) Informed Consent, (4) Benefit, Costs and Reciprocity, (5) Harm and Risk, (6) Honesty and Trust, (7) Privacy, Confidentiality and Anonymity, (8) Intervention and Advocacy, (9) Research Integrity and Quality, (10) Ownership of Data and Conclusions, and (11) Use and Misuse of Results. Each of these must be assessed at the beginning of the research, and on a continual basis as the research evolves. The examination of the axiological view has prepared the researcher to deal with the ethical issues that will be encountered during the research. Specific mitigations will be discussed in the research design of Chapter 4.

3.2.4 METHODOLOGICAL VIEW

The methodological view involves both the researcher's personal experience with qualitative, quantitative and mixed-methods research and the problem under study. While this researcher has rich experience in the quantitative hypothetico-deductive realm of research, the problem under study necessitates the inclusion of the rich contextual environment in the analysis and as such requires the use of qualitative methods. In this research, a theory building methodology is required for the construction of the competency model framework. A number of theory building methodologies were examined. Gioia and Pitre note that "theory building discussions seem to proceed as if the principles of theory building are somehow universal and transcendent across disparate paradigms of thought and research. They are not" (Gioia & Pitre, 1990, p. 584). They

define theory as "a coherent description, explanation and representation of observed or experience phenomena" (Gioia & Pitre, 1990, p. 587).

Torraco (2002) presents an anthology of five applied science theory building methodologies. These are represented in Table 2: Potential Theory Building Methodologies, with the title, a brief discussion extracted from Torraco, and the researcher's assessment of the place of the methodology in this research. Dubin's theory building approach is oriented to the quantitative perspective. He provides a template for building a theory that will most likely be expressed as an equation with limitations expressed as some confidence level. Dubin (1978, p. 222) does note that "the models of observable reality constructed are for the purpose of satisfying men's needs, however he defines them." Grounded theory was determined to be the most suitable approach based on its ability to serve as an inductive theory building engine, but the researcher perceived it was lacking the crucial induction step. As will be discussed later, the research came to rely on grounded theory for its ability to handle large volumes of data, but a way to cross from data to theory was lacking and research for how to cross that step was pursued.

Lynham proposes a generalized theory building approach, which seems to fly in the face of earlier discussions by Gioia and Pitre. Lynham does argue the general approach is flexible enough for a wide number of inquiries. And she provides a representation of the recursive nature of theory building and expertise. This is displayed in Figure 9.

Table 2: Potential Theory Building Methodologies

Title	Discussion	Conclusion
Dubin's theory-building method.	Dubin's (1978) method for theory building follows the quantitative research tradition and takes a hypothetico-deductive approach to knowledge creation. This method is based on the assumptions that knowledge is created to explain, predict, and control the phenomenon of interest; that new knowledge (theory) should serve technical/utilitarian interests for interrelating means and ends; and that the discovery of generalizable laws and explanations of human and organizational phenomena is possible and desirable (Torraco, 2002, p. 356).	Does not support inductive theory building.
Grounded Theory building.	Grounded Theory follows an inductive approach to generating or discovering theory. Theory evolves during grounded theory building through continuous interplay between analysis and data collection. Throughout the research process, theory is provisionally verified through a rigorous process of continuous matching of theory against data. Thus, grounded theory is distinctive in its approach to theory building because of its singular commitment to allowing new theoretical understandings to emerge from the data. Theory derived in this way is intended to be closely connected to evidence through the continuous analysis and comparison of data and emergent theory. Rigorous matching of data with theory is pursued for verification of the resulting hypotheses throughout the course of the theory-building process. In this way, grounded theory strives for authenticity—that is, a faithfulness to the data that closely reflects the meanings and understandings of those involved in the phenomenon being modeled by the theory (Torraco, 2002, p. 357).	Begins hypothesis free and seeks to uncover new theory from data.
Meta-analytic theory building.	Meta-analysis uses formal statistical techniques to sum up a body of separate but similar empirical studies. The purpose of meta-analysis is to synthesize and organize existing empirical findings on a topic into a coherent pattern. The meta-analytic approach seeks general conclusions across multiple studies as the basis for theory building (Torraco, 2002, p. 361).	Does not support inductive theory building.
Social constructionist theory building.	Theory building for the social constructionist is not undertaken to uncover a theoretical truth or reality but to model an understanding of the sense that people make of the social world in their everyday lives (Torraco, 2002, p. 361).	Does not support inductive theory building.
Theory building from case study research.	Case study research focuses on understanding the dynamics present within single settings. Although case study research and theory building from case study research are both based on the study of phenomena present within case settings, these research activities represent distinct contributions to new knowledge. Case study research takes advantage of the rich context for empirical observation provided by case settings to study a selected phenomenon using qualitative or quantitative methods without offering formal theoretical interpretations of the study. On the other hand, theory building from case study research generates explicit theoretical statements that explain the dynamics of phenomena occurring within case settings (Torraco, 2002, p. 362).	Appropriate for phase 5 of this research.

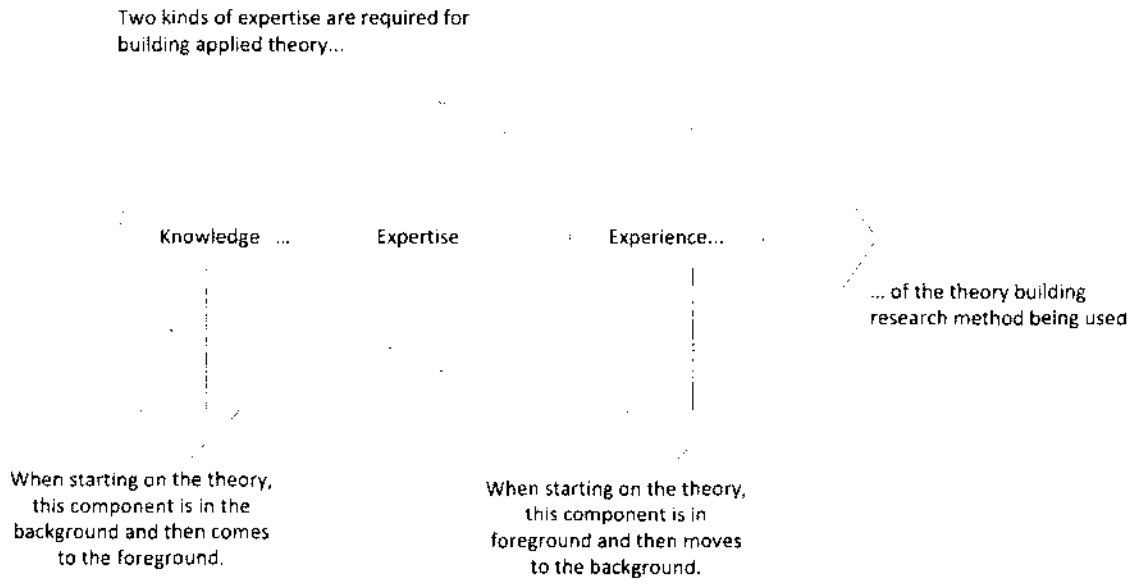


Figure 9: The Recursive Nature of Practical and Theoretical Expertise Inherent in Applied Theory Building Research (adapted from (Lynham, 2002, p. 230)).

Lynham's proposals provided a lead to the early inductive reasoning of Francis Bacon, which then leads to the *Discoverer's Induction* of William Whewell. The first segment of the research methodology uses qualitative inductive theory construction to develop a theoretical framework for competency model design, assessment and transformation. The framework development uses Discoverer's Induction at the crucial step of creating the actual framework. This method is founded on the literature intensive research effort to expose empirical facts used in the process of colligation. Snyder describes colligation as:

> Colligation is the mental operation of bringing together a number of empirical facts by 'superinduced' upon them some idea or conception that unites the facts and renders them capable of being expressed by a general law. (Snyder, 1997, p. 585)

Colligation is a purposeful action whereby the researcher adds something to the facts, which enables a new point of view or understanding. This research creates a competency model framework based on systems theory as the new theoretical point of view. Recalling the first research question, "*What framework can be developed for the analysis of competency models from a systems theory perspective?*" This question is answered by the development of the competency model framework. Discoverer's Induction requires validation, which will be served by phase 5 of this study, the case study.

Phase 5 of the research methodology uses a qualitative case study design to assess an extant competency model against the competency model framework. The case study design was selected in order to study competency models within their real-world context. As Yin notes, case studies are applicable to inquiries that:

- Investigate a contemporary phenomenon in depth and within its real-life context, especially when
- the boundaries between phenomenon and context are not clearly evident....
- cope with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result
- relies on multiple sources of evidence with data needing to converge in a triangulating fashion, and as another result
- benefit from the prior development of theoretical propositions to guide data collection and analysis. (Yin, 2009, p. 18)

The systems theory based competency model framework developed in the inductive segment is validated in the case study segment by answering the second research question *"What results from application of the systems theoretic competency model framework to analyze a competency model in an operational setting?"*

3.3 ROLE OF THE RESEARCHER

Figure 10 is a high level representation of the proposed research. This representation displays the logic that links the facts to be collected to the study questions. The facts in this research came from literature data search. The preliminary literature review and gap identification is conducted in Phase 1, research questions are finalized in Phase 2, a detailed literature data search is used as the source for the grounded theory analysis in Phase 3, inductively creating the competency model framework as well as creating the case study questions is accomplished in Phase 4, and the case study is conducted in Phase 5. It provides the five important components of the case study design: (1) the study's questions, (2) the propositions, (3) the units of analysis, (4) the logic linking the data to the propositions, and (5) the criteria for interpreting the findings (Yin, 2009).

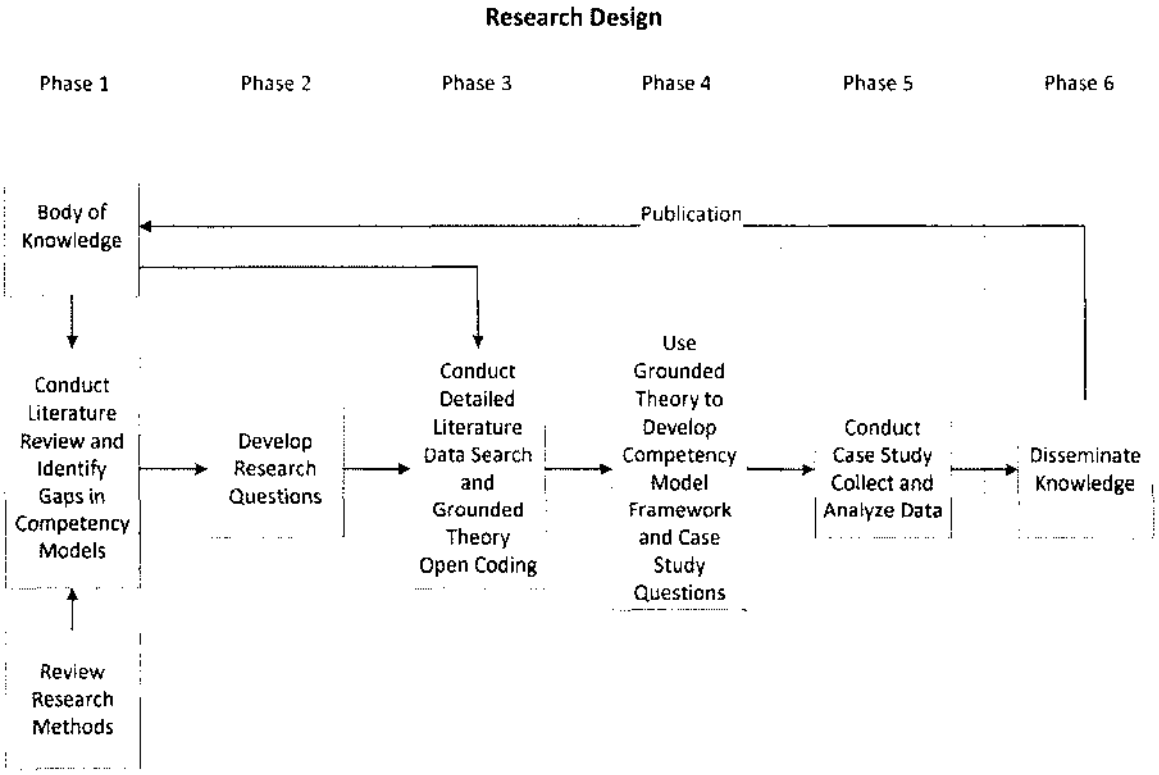


Figure 10: Research Design

The canons of science will be discussed within the frame of the methodology designed for this research in a later section.

3.4 SELECTION OF THE LITERATURE FOR THEORY BUILDING

Systems theory is a relatively young discipline, without a widely acknowledged agreement on the body of knowledge that defines the discipline. Jackson and Keys (1984) sought to define a of *system of systems methodologies* by comparison to Operations Research and other "systems based problem solving methodologies" (Jackson & Keys, 1984, p. 473). Jackson and Keys proposed classifications of *systems* and *decision makers*, enabling in their view the classification of problem contexts based on the two earlier classifications. Following the development of the problem solving framework, Jackson

and Keys sought to draw the literature that informs work supporting their framework, or arising out of consideration of the framework, Within the space of a few pages, they include Ackoff (OR), Bertalanffy (open systems), Jenkins and Hall (SE), Checkland and RAND (SA), Beer and Morgan (Cybernetics), Churchman, Mitroff, and Rittel as authors within the sphere of systems theory. Jackson and Keys were highly influential in changing or informing the direction of systems theory research, and were predecessors for others who sought to clarify the boundaries on what systems theory is. Jackson returned to the subject in *Beyond a System of Systems Methodologies* (Jackson, 1990, p. 667), developing five critical intentions:

> (i) to reveal and critique the theoretical (ontological and epistemological) bases of earlier management science approaches:
>
> (ii) to reflect upon the problem-situations in which earlier approaches can properly be employed and to critique their actual use;
>
> (iii) to develop management science beyond its present limitations and, in particular, to facilitate the emergence of new methodologies to tackle problem-situations where the operation of power prevents the proper use of soft systems thinking;
>
> (iv) to reflect upon the relationship between different organizational and societal interests and the dominance of particular management science methodologies and techniques;
>
> (v) to provide practically useful, theoretically sound approaches to problematic situations that will assist in the larger project of progressive social change.

Warfield proposed a set of laws as the basis for a "core for the developing science of complexity..." (Warfield, 1999, p. 1). Warfield sought to relate the complexity evidenced in his proposed laws to organizational design and resulting infrastructure. Warfield identified two *killer assumptions* that he felt were locked into the corpus of business practice. These are the assumptions of *adequate executive capacity* and *reliable organizational information flow*, neither of which appeared to be supported "in a scientifically supportable way" (Warfield, 1999, p. 5). Warfield then describes a complexity resolving system, the requirements for such a system, and the scientific underpinnings of such a system. Warfield's focus on organizational improvement using the sciences is reflected in a later paper describing the required elements of systems science. Like Jackson, he characterizes it as a young science, one that should have five distinct roles. Those roles are: (1) a science of description, (2) a science of generic design, (3) a science of complexity, (4) a science of action, and (5) "*as a science that is open to imports from other disciplines and incorporates means of identifying and integrating essential components of those disciplines*" (Warfield, 2003, p. 507). Warfield goes on to propose that Systems Science must include all five distinct roles and the purpose "of systems science is to provide the avenue to resolution of problematic situations of whatever nature that arise from whatever source" (Warfield, 2003, p. 515). Warfield concluded that:

> The challenge for the future of systems science does not lie in any further development of neutral sciences, although minor changes might be seen from time to time. The challenge lies in the arena of systems science. Everywhere on earth there exist problematic situations awaiting resolution by human action.

> To this point many of these situations have been dealt with in ad hoc ways by uninformed and/or self-serving politicians and weak systems methods, or by war that may be incited by inability to articulate and resolve the complexity that occupies human attention. (Warfield, 2003, p. 518)

While Warfield proposed one set of laws, with supporting research, Adams and his colleagues have proposed a more recent re-visioning of the body of knowledge that can define systems theory (Adams, Hester, Bradley, Meyers, & Keating, 2014). Drawing from a wide number of scientific fields defined by the Organization for Economic Development, the authors have proposed an architecture familiar in many other sciences – the use of axioms and propositions as the structure for the science. Using seven axioms and 30 propositions, systems theory is proposed as a construct. This research proposes to use the literature supporting the primary proponent of each proposition as the corpus for construction of the competency model framework as depicted in Table 3: Alphabetical Listing of Systems Propositions.

Table 3: Alphabetical Listing of Systems Propositions

Axiom	Proposition and Primary Proponent	Brief Description of the Systems Proposition
Centrality	Communication (C. E. Shannon, 1948a, 1948b)	In communication, the amount of information is defined, in the simplest cases, to be measured by the logarithm of the number of available choices. Because most choices are binary, the unit of information is the *bit*, or binary digit.
	Control (Checkland, 1993)	The process by means of which a whole entity retains its identity and/or performance under changing circumstances.
	Emergence (Aristotle) (Sachs, 1999)	Whole entities exhibit properties which are meaningful only when attributed to the whole, not its parts – e.g. the smell of ammonia. Every model of systems exhibits properties as a whole entity which derive from it component activities and their structure, but cannot be reduced to them (Checkland, 1993).
	Hierarchy (Pattee, 1973)	Entities meaningfully treated a wholes are built up of smaller entities which are themselves wholes . . . and so on. In a hierarchy, emergent properties denote the levels (Checkland, 1993).
Contextual	Complementarity (N. Bohr, 1928)	Two different perspectives or models about a system will reveal truths regarding the system that are neither entirely independent nor entirely compatible.
	Darkness (Cilliers, 1998)	Each element in the system is ignorant of the behavior of the system as a whole, it responds only to information that is available to it locally. This point is vitally important. If each element 'knew' what was happening to the system as a whole, all of the complexity would have to be present in that element (Cilliers, 1998).
	Holism (Smuts, 1926)	The whole is not something additional to the parts: it is the parts in a definite structural arrangement and with mutual activities that constitute the whole. The structure and the activities differ in character according to the stage of development of the whole; but the whole is just this specific structure of parts with their appropriate activities and functions (Smuts, 1926).

Table 3: Alphabetical Listing of Systems Propositions (Cont)

Axiom	Proposition and Primary Proponent	Brief Description of the Systems Proposition
Design	Minimum Critical Specification (Cherns, 1976, 1987)	This principle has two aspects, negative and positive. The negative simply states that no more should be specified than is absolutely essential; the positive requires that we identify what is essential.
	Pareto (Pareto, 1897)	Eighty percent of the objectives or outcomes are achieved with twenty percent of the means.
	Requisite Parsimony (G. Miller, 1956)	Human short-term memory is incapable of recalling more than seven plus or minus two items (Simon, 1974).
	Requisite Saliency (Boulding, 1966)	The factors that will be considered in a system design are seldom of equal importance. Instead, there is an underlying logic awaiting discovery in each system design that will reveal the saliency of these factors.
Goal	Equifinality (Bertalanffy, 1950a)	If a steady state is reached in an open system, it is independent of the initial conditions, and determined only by the system parameters, i.e. rates of reaction and transport.
	Multifinality (Buckley, 1967)	Radically different end states are possible from the same initial conditions.
	Purposive Behavior (Rosenblueth, Wiener, & Bigelow, 1943)	Purposeful behavior is meant to denote that the act or behavior may be interpreted as directed to the attainment of a goal-i.e., to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event.
	Satisficing (Simon, 1955, 1956)	The decision making process whereby one chooses an option that is, while perhaps not the best, good enough.
	Viability (Beer, 1979)	A function of balance must be maintained along two dimensions: (1) autonomy of subsystem versus integration and (2) stability versus adaptation.
Information	Redundancy of Potential Command (McCulloch, 1959)	Effective action is achieved by an adequate concatenation of information. In other words, power resides where information resides.
	Information Redundancy (C. E. Shannon & Weaver, 1949)	The number of bits used to transmit a message minus the number of bits of actual information in the message.
	Homeorhesis (Waddington, 1957, 1968)	The concept encompassing dynamical systems which return to a trajectory, as opposed to systems which return to a particular state, which is termed homeostasis.

Table 3: Alphabetical Listing of Systems Propositions (Cont)

Axiom	Proposition and Primary Proponent	Brief Description of the Systems Proposition
Operational	Dynamic equilibrium (D'Alembert, 1743)	For a system to be in a state of equilibrium, all subsystems must be in equilibrium. All subsystems being in a state of equilibrium, the system must be in equilibrium.
	Homeorhesis (Waddington, 1957, 1968)	The concept encompassing dynamical systems which return to a trajectory, as opposed to systems which return to a particular state, which is termed homeostasis.
	Homeostasis (W. Cannon, 1929)	The property of an open system to regulate its internal environment so as to maintain a stable condition, by means of multiple dynamic equilibrium adjustments controlled by interrelated regulation mechanisms.
	Redundancy (Pahl, Beitz, Feldhusen, & Grote, 2011)	Means of increasing both the safety and reliability of systems by providing superfluous or excess resources.
	Relaxation Time (Holling, 1996)	Stability near an equilibrium state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property. The system's equilibrium state is shorter than the mean time between disturbances.
	Self-organization (Ashby, 1947)	The spontaneous emergence of order out of the local interactions between initially independent components.
	Suboptimization (Hitch, 1953)	If each subsystem, regarded separately, is made to operate with maximum efficiency, the system as a whole will not operate with utmost efficiency.
Viability	Circular causality (Korzybski, 1958)	Any effect becomes a causative factor for future effects, influencing them in a manner particularly subtle, variable, flexible, and of an endless number of possibilities.
	Feedback (Wiener, 1948b)	All purposeful behavior may be considered to require negative feed-back. If a goal is to be attained, some signals from the goal are necessary at some time to direct the behavior.
	Recursion (Beer, 1979)	The fundamental laws governing the processes at one level are also present at the next higher level.
	Requisite Hierarchy (Aulin-Ahmavaara, 1979)	The weaker in average are the regulatory abilities and the larger the uncertainties of available regulators, the more hierarchy is needed in the organization of regulation and control to attain the same result, if possible at all
	Requisite Variety (Ashby, 1956)	Control can be obtained only if the variety of the controller is at least as great as the variety of the situation to be controlled.

The literature represented in Table 3 is not exhaustive, but is sufficient to provide the depth and breadth of the propositions of systems theory. The authors made use of previous definitions of systems theory by respected authors as the launching point for the collection with the goal of increasing the explanatory power and interpretation of systems. Using the architecture of axioms and propositions commonly found in "hard" sciences, the authors seek to develop a formal definition and construct for systems theory.

3.5 DATA COLLECTION STRATEGY

The data collection strategy is relatively straightforward. Each of the documents listed in Table 3: Alphabetical Listing of Systems Propositions was acquired, generally in an electronic format, verified to be the effective version of the document and maintained as the record copy for the duration of the research. Additional data was collected as discussed in Chapter 4.

3.6 DATA ANALYSIS STRATEGY

As discussed earlier, Whewell's Discoverer's Induction is used to develop the competency model framework. In describing science, Whewell actually defined induction as "in all these Sciences it is familiarly understood and assumed, that their doctrines are obtained by a common process of collecting general truths from particular observed facts, which process is termed Induction" (Whewell, 1858, p. 4). Ducasse notes that:

> The fundamental contention of Whewell's theory of knowledge is that all knowledge essentially involves the antithesis of two elements. One of them is given to us by pure observation, and the other is superimposed by ourselves

upon what we observe. Only when the two elements are united do we have knowledge properly so-called. (Ducasse, 1951a, p. 58)

Ducasse tabulates the steps for induction as shown in Table 4: Summary Statement of the Elements of the Inductive Process as Conceived by Whewell (Ducasse, 1951a, p. 214).

Table 4: Summary Statement of the Elements of the Inductive Process as Conceived by Whewell (Ducasse, 1951a, p. 214)

First Step: Clarification of the Elements of Knowledge by Analysis:	
	: Explication of Conceptions
	: Decomposition of Facts
Second Step: Colligation of Facts by means of a Conception:	
	: Selection of the Idea
	: Construction of the Conception
	: Determination of the Magnitudes
Third Step: Verification of the Colligation	

This Discoverer's Induction begins with the Clarification of the Elements of Knowledge by Analysis. There are two parts to this step, the Explication of Conceptions and Decomposition of Facts. The Explication of Conceptions (Ducasse, 1951a, p. 213) is described by Whewell as:

> We have given the appellation of Ideas, to certain comprehensive forms of thought, - as space, number, cause, composition, resemblance - which we apply to the phenomenon which we contemplate. But the special modifications of these ideas which are exemplified in the particular facts, we have termed conceptions; (Whewell, 1840, p. 42)

Whewell did not propose, nor believe, a tool was possible for this step. However, it was the product of debate and discussion and could be expressed as a problem statement (Ducasse, 1951b).

The Decomposition of the Facts is the next step, which requires a collection of the facts (Ducasse, 1951b). This portion of the research involves the analysis of the body of knowledge described in Table 3: Alphabetical Listing of Systems Propositions. Each of the represented pieces of literature is broken down via coding to ascertain the facts that will be used for the next phase. Coding is also an inherently bounding process. A phenomenon is given a conceptual label and thus a bound is provided by the researcher to the phenomena. Coding is described by Miles and Huberman as "a critical data-reduction tool" (Miles & Huberman, 1984a, p. 25) that is "developed inductively or driven by research question" (1984a, p. 25). They provide several examples of coding, and provide value judgments on the coding schema they report upon (1984b). Miles provides details of one research effort that produced several hundred codes that eventually led to the total abandonment of the coding effort. Ultimately, the only benefit was the "arguments and clarifications they required were successful in generating a common language of concepts, which found their way into the general framework, and guided further data analysis in less-formal modes" (1979, p. 594). The bounding was not as successful as desired in the project discussed by Miles, but served as a guidepost for this research. In Chapter 4, the efforts to enable bounding will be further discussed, with an assessment by the external reviewers of the success.

The second step is the colligation of the facts. There are three elements to this step, and it is in fact the heart of the inductive inquiry. The *Selection of the Idea* requires

the researcher to examine the Ideas revealed by the Explication of Conceptions and the Facts determined by the Decomposition of the Facts. This examination requires the researcher to have a General Conception superinduced upon the Facts. In more modern terms, the researcher's careful assemblage of the Ideas and Facts, combined with characteristics described by Ducasse as "the possession of a fertile, sagacious, ingenious and honest mind" (Ducasse, 1951b, p. 222). The key step is the superinduction of the theory upon the collection of the facts that have been colligated. This will be the step that actually creates the framework.

Ducasse summarized Whewell's seven methods for the Construction of the Conception. Most are quantitative, but the method that applies to this research is the Method of Natural Classification. Whewell developed the method for early biological researchers seeking to understand what is now called taxonomy. However, the process will be used with a modern classification technique, grounded theory, to develop the competency model framework structure and details. The next section will discuss how grounded theory was used to accomplish development of the competency model framework.

Whewell required Verification of the Colligation as the third and final step. This is not an inductive theory building step, but a deductive testing step. The research design accomplished one case study as the Verification of the Colligation. That process is discussed in detail in the next section.

The foregoing discussion is insightful in developing inductive theory, but the large mass of data required for this research required a method able to handle such a

volume. Grounded theory was selected and is first discussed in the next section and more thoroughly discussed in Chapter 4.

3.7 BUILDING THE FRAMEWORK USING GROUNDED THEORY

Figure 10 presents a diagram of the overall research plan. The detail of the phase "Competency Model Framework Informed by Systems Theory" is illustrated in Figure 11. The plan begins with the description of the research purpose and outline of the research questions, and proceeds to the development of the research design including literature data collection, data analysis, theory building and framework development. As noted earlier, Whewell's Discoverer's Induction was used to build the framework. However, Discoverer's Induction provides few details of the earlier processes, especially in the data rich environment of this research. Three alternative methods were examined for this research: content analysis, dynamic network analysis and grounded theory. Grounded theory was selected as the method to supplement Discoverer's Induction. The use of grounded theory brings a rigorous, well-documented method (Corbin & Strauss, 1990) as well as availability of supplemental tools (i.e. software) to aid the researcher. Grounded theory has a number of similarly well-documented weaknesses which will be mitigated by the research design.

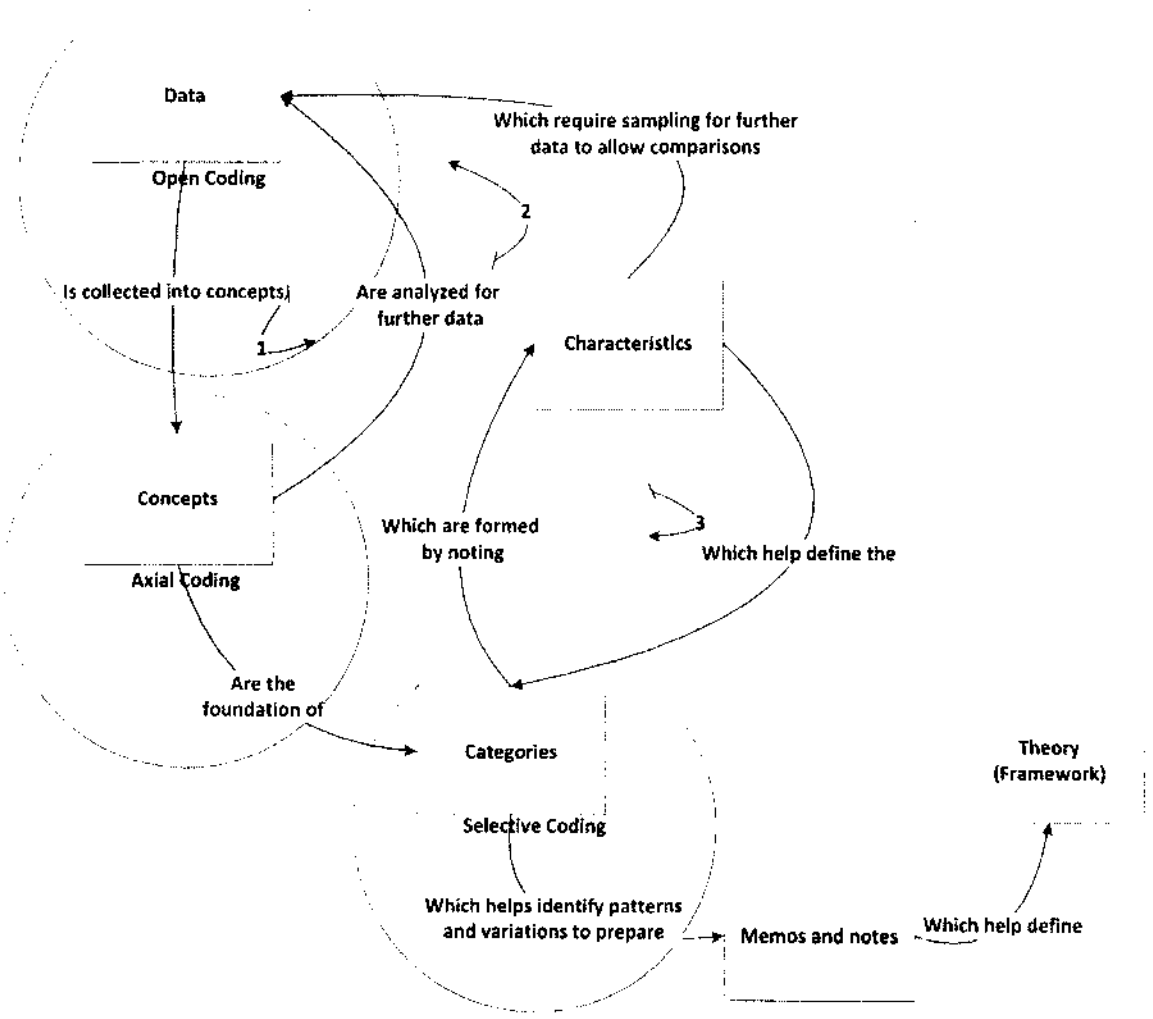


Figure 11: Grounded Theory Flow Path

Grounded theory proponents provide cautions to researchers to limit the exposure or influence of existing literature early in the research, using the term *theoretical sensitivity*. While systems theory is necessary to place the research in the context of the body of knowledge, the researcher limited exposure to preclude undue influence during the preparations for this research.

The grounded theory processes are not strictly linear, and Figure 11 captures the iterative relationship between the steps for data collection and data analysis, using the

constant comparative method of grounded theory. As data is analyzed, and concepts identified and categories were developed, the research required returning to the data to provide assurance that the emerging theoretical constructs were actually grounded in the data (Corbin & Strauss, 1990).

There were three phases of coding as part of the data analysis. Those three phases are open coding, axial coding and selective coding (Leedy & Ormrod, 2010). Following selective coding, theory development was accomplished. An initial discussion of the details of each of these phases is provided in Table 5 below:

Table 5: Data Analysis (drawn from (Leedy & Ormrod, 2010, p. 143))

Phase	Activities
Open Coding	The data are divided into segments and then scrutinized commonalities that reflect categories or themes. Data are examined for properties that characterize each category.
Axial Coding	Interconnections are made among the categories and subcategories.
Selective Coding	The categories in their interrelationships are combined to form a storyline that describes what happens.
Theory Development	A theory, in the form of a verbal statement, visual model, or series of hypotheses is offered to explain the phenomenon in question.

The "Theory Development" phase in Table 5 is where the coding explicitly merges with the superinduction of Discoverer's Induction. While the coding process is not completely separated from the inductive theory building, that theory building was distilled once the fermenting coding steps were complete. However, it is appropriate to touch on several criticisms of grounded theory, as those criticisms bear on the design. In

particular, the researcher identifies the specific strategies that have been built into the design, where possible, to nullify the criticisms with respect to this research effort.

3.8 CRITICISMS OF GROUNDED THEORY

As one would expect, criticisms of the grounded theory have been reported. One of the earliest criticisms actually arises from the two discoverers of grounded theory concerning their disagreement of the role of literature in the process of building theory. Recall that the basic theme of Glaser and Strauss was "discovery of theory from data systematically obtained from social research" (Glaser & Strauss, 1967, p. 2). While they recognized that no researcher came to the problem without some existing knowledge based on prior reading or experience, the desire was to limit the effect of preconceived notions on the theory being built (Heath & Cowley, 2004). Thus the detailed guidance published by Strauss and Corbin (1998) was the confirmation of the divergence from Glaser in perspectives on literature review.

Heath and Cowley (2004) also describe the differences in the role of induction, deduction and verification in grounded theory, both as the method has evolved and how it has diverged between Glass and Strauss. Figure 12, Figure 13, and Figure 14 depict the differences and the evolution of the relationship of deductive, inductive and verification elements in grounded theory. The depiction of the evolution of the elements allows the researcher to select the appropriate order for this research. Figure 14 is the most representative of the mental model held by the researcher for this research. It portrays the collection of data followed by a cyclic deductive and verification process, culminating in the creation of a paradigm model that is translated into the theory (framework).

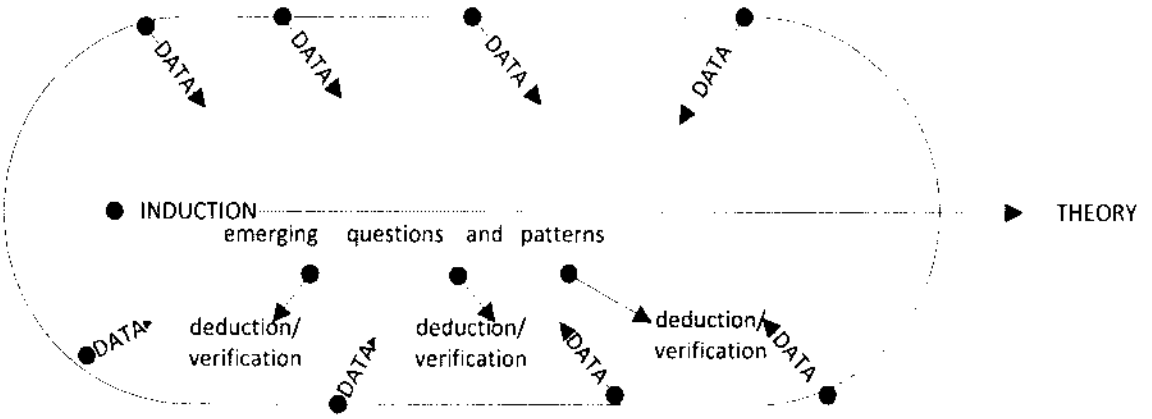


Figure 12: Place of Induction, Deduction and Verification in Glaser (adapted from Heath and Cowley (2004, p. 144)

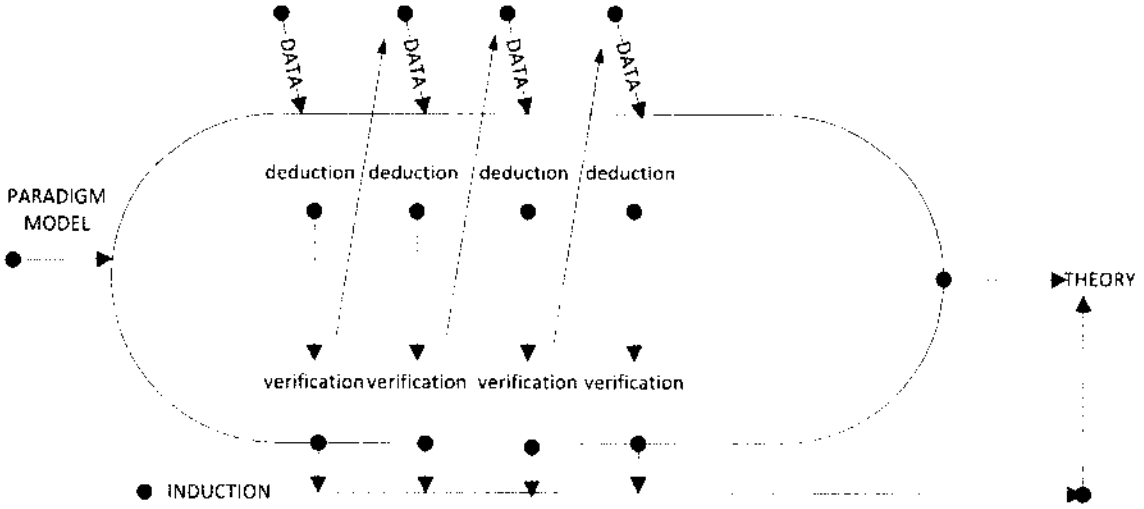


Figure 13: Place of Induction, Deduction and Verification in Glaser, and Strauss and Corbin (adapted from Heath and Cowley (2004, p. 145))

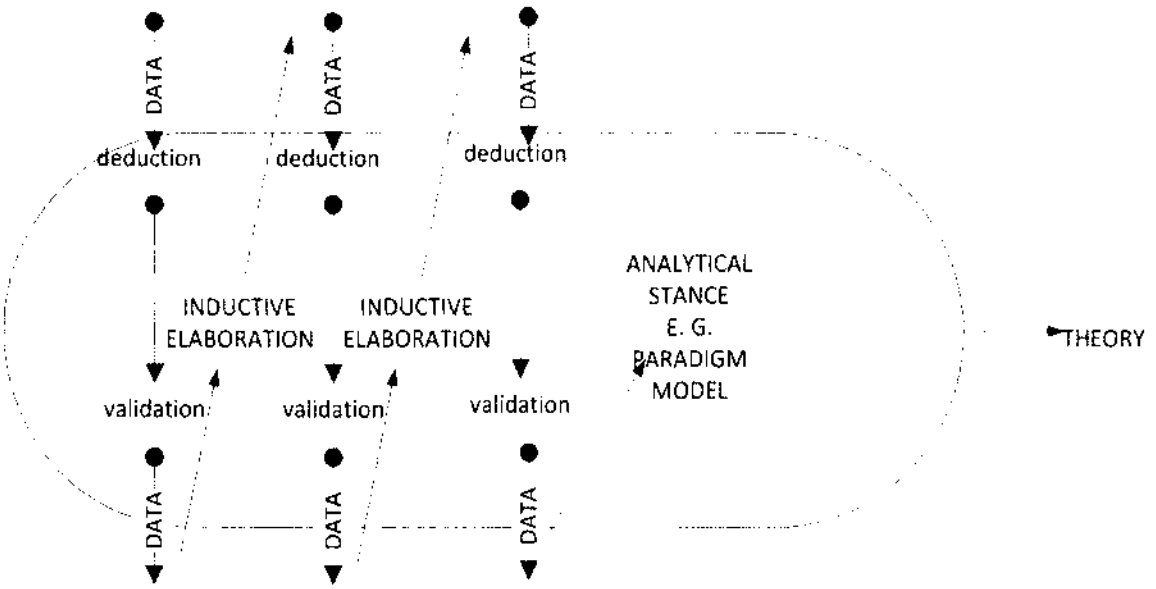


Figure 14: Place of Induction. Deduction and Verification in Strauss and Corbin (1998) (adapted from Heath and Cowley (2004, p. 145))

Heath and Cowley offer that "the researcher should mix the two approaches with caution, aware that they may violate philosophical underpinnings of both; boundaries between the two should be maintained rather than a synthesis attempted" (2004, p. 147).

Strauss and Corbin discuss the diffusion of grounded theory and express concern for the speed and breadth at which this diffusion has occurred. They express this as the "risk of becoming fashionable" (Strauss & Corbin, 1994, p. 277). They outline several concerns, including focus on coding to the exclusion of building theory and using the term *grounded theory* for any inductively based research. The implication is that a grounded theory researcher needs to be well versed in the entirety of the process, rather than focusing on only part of the methodology that piques his or her interest.

Goulding also discusses problems encountered when using grounded theory. She discusses the potential pitfall of the researcher placing "too much emphasis on identifying

codes, without theoretically coding" (Goulding, 1999, p. 18). Theoretical coding is the phase where those codes are related to one another, by the very theory that is being built. Goulding also notes that some researchers do not maintain the constant comparison as a feature of their process. This can lead to incomplete relationships and thus an incomplete theory. In this context, the theory "should only be presented as developed when all core categories are saturated" (1999, p. 18).

The foregoing criticisms all bear on the research design, preparation and execution. From the very beginning of this concept, the researcher endeavored to not jump ahead and dive into the systems literature to prevent from being biased in the approach. It was only with the submission of the candidacy exam and the completion of the research proposal that the researcher began assembling the literature to construct the framework. While *framework* is used throughout the dissertation, the grounded theorists use the term *theory* to describe what has been constructed.

The evolution of the relationship of induction, deduction and verification is critical to the development of the theory (framework). It will clearly require elements of each, but relies heavily on Discoverer's Induction to create that new and currently missing piece for the development of competency models. By having an explicit diagram, like Figure 15, it guides the researcher in the daily execution of the tasks at hand.

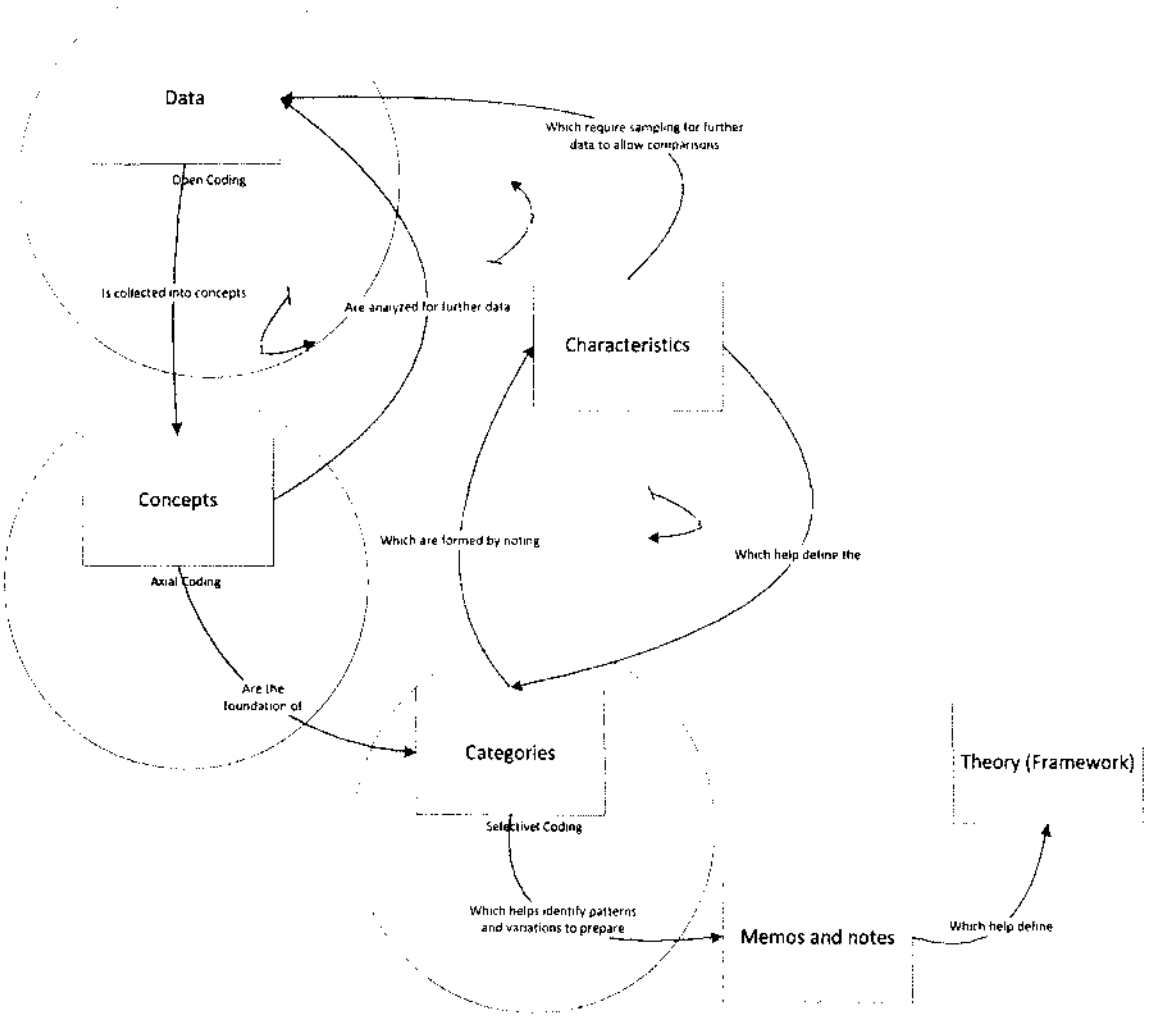


Figure 15: Grounded Theory Flow with Iterative Paths

Also the details of Figure 15 were helpful in addressing the concerns raised by Straus and Corbin as well as Goulding about the researcher understanding where in the research one is at. At the core, they speak of the researcher losing sight of the whole picture by being caught up in some important but small part of the research. A set of roadmaps was constructed for this research and detailed procedures developed at key stages (e.g. Figure 21).

3.9 APPROPRIATE RESEARCH QUESTIONS FOR GROUNDED THEORY

It is crucial for the researcher to select methodologies that will allow the conduct of successful research. The researcher must similarly be cognizant of the research method and its alignment with his/her ontological and epistemological perspectives. The discussion begins at a general discussion of the applicability of grounded theory and moves to more specific examples. Returning to Goulding, she notes that:

> unlike quantitative methods where, for example, a copy of the questionnaire and statistical analysis can be inserted in the appendix for full justification and evidence of findings, with qualitative research it is impossible to provide the full evidence in a manner that is as immediately accessible to the reader. (Goulding, 1999, p. 18)

Goulding later points out "grounded theory will not appeal to the researcher in search of absolute certainties, neatly defined categories and objectively measured explanations" (Goulding, 1999, p. 19). Just as the researcher cannot require the certainty of outcome, the research problem cannot be one that requires such positivist certainty. A theme throughout the grounded theory literature is the continuous work required to move the theory forward, as even the social organizations that were the subject of a particular study evolve, the theory must evolve. Unlike chemistry, where a certain weight of salt added to a specified volume of pure water produces an exact salinity and has every time the experiment has been performed, humans change and evolve and so do their systems.

Proceeding from those general ideas, we look at a specific discipline or context that might preclude grounded theory from being selected as the research method. The

first has to do with the size of the problem and thus the volume of data. One paper had the following discussion:

> One very practical problem with grounded theory is that the method is extremely labour intensive, requiring the investment of considerable cognitive effort by the knowledge engineer. Hence we would recommend that some time is spent at the definition stage of any project in deciding whether the rich conceptual models generated by this approach are indeed appropriate for the intended application. Factors bearing upon such a decision would include the data that is potentially available (and its quality and form); the characteristics of the problem domain; and the ultimate system requirements. A related issue concerns the operations at the heart of the interpretative process. Key choices about the labeling and reordering of the data, together with decisions about the nature of the expert model which is to be devised are not readily open to specification in advance. The knowledge engineer must produce solutions to the latter problems for each particular case, having regard to the requirements of the application being devised. (Pidgeon, Turner, & Blockley, 1991, p. 169)

Pidgeon and his team focused on the *knowledge engineer*, implying a single researcher. One way around this problem is to recall Corbin and Strauss' procedure (10) that a grounded theorist need not work alone (Corbin & Strauss, 1990). While this will introduce other problems, adding a researcher or more would increase the scale of the problem that can be approached, reduce the time to complete the study and provide multiple perspectives during the theory building. This researcher found the volume of material to be manageable with only one researcher.

While the previous example focused on problems that might dissuade using grounded theory, an examination of fields where grounded theory was unsuccessful instead found the opposite. There are numerous examples of fields where grounded theory has been successfully used. Medicine, in particular many facets of nursing, has seen research conducted with grounded theory. An additional perspective that was included in the search was for research that touched on competency models. While the orientation may have been different, having a number of studies in competency models with grounded theory made this approach more defensible.

Using grounded theory, Sherman, Bishop, Eggenberger and Karden (2007) studied perspectives on critical leadership skills for nurse managers with the goal of developing a competency model for mentoring the next generation of nursing leaders. Walsh, Gordon, Marshall, Wilson and Hunt developed, using grounded theory, an Interprofessional Capability Framework that "articulates the learning outcomes that students need to achieve and continue to develop in order to become interprofessional workers" (2005, p. 230). Kan and Parry investigated nursing leadership in a hospital setting using grounded theory. They developed a theory on how organizational politics both assisted and confounded the process of leadership (Kan & Parry, 2004). Earlier, Parry had examined how leadership could be examined using grounded theory. Parry proposed that the richness of grounded theory might be better at developing an integrative theory of leadership than the previous quantitative psychology approach. While being a proponent of grounded theory being used for studying leadership, Parry discusses concerns with validity and reliability. He reviews techniques or protocols to aid the researcher in overcoming concerns with validity and reliability. An example he

provides is how to deal with underreporting the weight of critical incidents by the organization's members. Parry concludes with a selection of research objectives for grounded theory in leadership (K. W. Parry, 1998). Within a decade, the use of grounded theory to study leadership had taken hold and spawned at least one text with 855 references (Nitecki, 2010).

Application of grounded theory has not been limited to the medical profession, but has seen application in studying web user *flow* experiences, where the *flow* refers to "a state of consciousness that is sometimes experience by individuals that are deeply involved in an enjoyable activity" (Pace, 2004, p. 37). Orton (1997) has reported on grounded theory in public policy, as have Kumar and Gantley (1999), Gardner and Abraham (2007), Tuler and Webler (1999) who have examined such diverse topics as motivations that drive car usage and their impacts on transportation policy and what the public expects from participatory government policy sessions.

The volume of literature confirms Strauss and Corbin's concern about diffusion, but at the same time, grounded theory has offered researchers a rigorous approach to problems that would not be able to be effectively addressed by a purely quantitative approach.

3.10 THEORETICAL SENSITIVITY AND SOFTWARE AIDS

Before leaving the discussion of research methodology, a brief discussion of the researcher's *theoretical sensitivity* is in order. This topic is directly related to one of the criticisms of grounded theory – the ability of a researcher to enter the research with a *tabula rasa*. From the origins of grounded theory, this concept has been of significant

concern. Glaser and Strauss note that the researcher "should also be sufficiently *theoretically sensitive* so that he can conceptualize and formulate a theory as it emerges from the data (Glaser & Strauss, 1967, p. 46)". The goal is to not allow pre-existing hypotheses or formulations drive the emerging theory. Committing early to a single preconceived theory blocks the researcher from seeing around "either his pet theory or any other. He becomes insensitive or even defensive, towards the kinds of questions that cast doubt on his theory (Glaser & Strauss, 1967, p. 46)". As grounded theory evolved, the recognition that a tabula rasa was not possible evolved to efforts to mitigate or even take advantage of the researcher's experience. Strauss and Corbin discuss the life experiences of the researcher that can add insight to the research. "It is amazing how insight sparks more insight and discovery builds (Strauss & Corbin, 1998, p. 48)."

For this research, a number of strategies were developed to enhance theoretical sensitivity. The first was not conceptualizing a framework structure from the beginning. There was not a preconceived notion of what the framework would look like it, and in fact, it evolved through the research. A second strategy was the use of external reviewers who provided midcourse inputs on the details of the literature data set and open coding. All inputs were assessed and feedback into the literature data set, codebook and open coding. A third element was the use of presentations of progress to varied audiences. The researcher presented formal updates to the committee, as well as informal briefings to peers, other researchers and users of competency models in government and industry. Their feedback was also assessed and resulted in several course changes during the research. The cumulative effect was to improve the researcher's theoretical sensitivity and resulted in an open approach to the framework development.

Qualitative research generates vast amounts of data, often unstructured data. Specialized software packages have been developed to aid the researcher manage this data. As the software is rapidly evolving, specific characteristics for consideration drive the software selection (Lewins & Silver, 2009). The researcher selected Nvivo version 10 based on a limited review of the major packages and relative ease of use during the trial period (Richards, 2013).

3.11 AN EXPLORATION OF FRAMEWORK, MODEL, AND SYSTEM

In earlier sections, the researcher has discussed the term *framework* and noted it is a synonym for *theory*. The terms *framework, model, and system* are frequently interchanged under the general notion that they offer a representation to serve (tacitly or explicitly) an intended purpose, objectives, and audience. This section develops a literature supported scholarly explication of the three terms *framework, model, and system.* It begins with a rigorous literature based scholarly perspective of the three terms, examines the differences and overlaps in the appropriate scholarly use of the terms, and applies specific criteria based guidance for scholars in selection and use the most appropriate term (framework, model, or system) for conduct of research that involves production of a representation. This section provides an understanding of the relationship of framework, model and system to enable understanding of the actual framework development that follows. This section concludes with a discussion of the axial coding processes used to develop the first details of the competency model framework based on the earlier open coding.

Framework is a relatively young word in scholarly works. Early uses of the word focused on some mechanical or structural meaning. An early description of a grain mill

(Bowes et al., 1800) includes the word when describing how a new hand corn mill was assembled, where:

> The bed-stone D rests upon two supporters of wood, one of which is shewn [sic] at I: these supporters are screwed to the block E, and also morticed [sic] into the lower frame-work of the mill at K: the frame-work is held together by pins or wedges L L L, which admit the Mill to be easily taken to pieces. (Bowes, et al., 1800, p. 220)

Within just a few short decades, the term *framework* was beginning to be used to describe a collection of ideas, instead of a merely physical arrangement of parts and pieces. A doctor, writing under the pseudonym Medicus, proposed the use of statistics as a tool to improve medical knowledge within "the great framework of that social and civic compact, which forms the British state" (Medicus, 1840, p. 40)! An ocean away, *framework* is clearly used to describe a collection of ideas that form a particular subject in a review written by Peter D. Barnard of a series of discourses on political science as an important branch of academic education (Barnard, 1841). The use of framework as a description of the mind's efforts to organize ideas or concepts was discussed by Boutwood, Hodgson, Carr and Lindsay:

> The unity of the world, in the sense just indicated, is something we discover, not something we produce. Our reflective thought interprets the world as a unity, but the unity which it predicates is not read by it into the world, but is read by it in the world. This, at least, is what our interpretative thought claims to be, -genuine interpretation, quite strictly a *construing*, not a *constructing*. The unity of the world is not, and cannot be, empirically given. It is never an

> empirically given fact, but, in our minds as a predicate of the world, it is always due to the characterization of thought. It is thus, "the work of the mind," but in that work the working mind is not composing a framework of its own devising upon unorganised facts, rather is it interpreting, by its own powers,-in the light of the laws of its own thought- a positively-given order which, alike in the existence of its constituent particulars and in its organic unity, is essentially independent of the mind that interprets it. (Boutwood, Hodgson, Carr, & Lindsay, 1901, p. 103)

Boutwood, et al. considered the world to be an ordered place, and "only because the world is actually an ordered world that our thought is able to construe it as such" (Boutwood, et al., 1901, p. 103). This concept, *that the world is ordered*, and it is our minds that discern the order and then translate that discernment into a representation, lies at the heart of the positivist world view. It is also one impetus to create frameworks that depict the relationships between seemingly disparate ideas, concepts or situations, in order to discover those relationships. Blumer, writing on the possibility of science without concepts, noted:

> Through abstraction one can isolate and arrest a certain experience which would never have emerged in mere perception. Our perceptual world is one of particulars, four although conception is always involved, it is conception working through particulars. The abstraction of a relation from this world of particulars, and the holding onto it, is possible only through conceptualization and necessitates, ultimately, a concept. That is to say, the very act of abstraction is an act of conception; if the conception is to be held on to it must

> be given a name, a sign, or an identifying mark. By identifying such an isolated content two developments of paramount importance for science are possible: (1) this content may become the object of separate investigation and reflection, (2) it may enter into the experience of others and so become common property. (Blumer, 1931, p. 520)

Blumer outlines the formation of individual concepts of mechanics into a "conceptual pattern which made possible and guided experimentation and became the framework of the early knowledge and laws of physics" (Blumer, 1931, p. 525). Blumer is referring to the personal in the first part, where the individual researcher uses the conceptual framework to guide future work, and to the community of scholars at large in the second part, where by making the framework accessible to others it can be tested, expanded, and developed, and ultimately to humanity when the framework becomes part of the larger culture. Blumer never defined framework in this paper, a common occurrence in many scholarly works (Barnard, 1841; Boutwood, et al., 1901; Medicus, 1840).

In later works, the word framework may not be defined, but the surrounding text describes its construction in sufficient detail to understand the author's purpose for selecting that term. Ulrich proposes a taxonomic framework for the design of problem solving systems. He proposes the framework by reference to a figure with accompanying description of the features in the figure (Ulrich, 1977). Oravis (1982) synthesized four earlier frameworks for organizational development into a single framework for assessing military organization organizational development. Zachman (1987) proposed a framework for information systems architecture. This framework is viewed as seminal in

the information systems architecture field and has achieved somewhat broader renown by penetrating outside the scholarly texts when it became part of the popular press's representation of systems architecture. In the field of competency models, frameworks have been constructed by a number of authors. Oravis, mentioned previously, was working with early competency models. Linthicum (2012) studied the response to chaos and training for first responders. Barrett examined complex change using a framework developed by Torbert for action logics (Barrett, 2012). Taylor, Cocklin, Brown and Wilson-Evered (2011) examined Complexity Leadership Theory and its framework with an interest in the competences required of *champions*, defined as emergent leaders.

Framework is explicitly defined by Checkland and Howell in *Information, Systems and Information Systems*. Noting that a framework is missing from many conceptions of an approach to researching human situations, Checkland and Holwell argue for "a declared-in-advance intellectual framework of ideas, a framework in terms of what constitutes 'knowledge' about the situation researched will be defined and expressed" (Checkland & Holwell, 1998, pp. 22-23). Checkland and Holwell provide Figure 16 illustrating the role of the framework of ideas within a research program or study. As Checkland and Holwell describe:

> the framework of linked ideas F are used in a methodology M to investigate some area of interest A. From doing the research, the alert researcher may learn things about all three elements. Plate tectonics are example of contemporary F, when A consists of earthquakes and volcanicity. The phlogiston theory of heat is a failed F from the 18th century. A natural science

M is the process of … testing to destruction of hypotheses. (Checkland & Holwell, 1998, pp. 23-25)

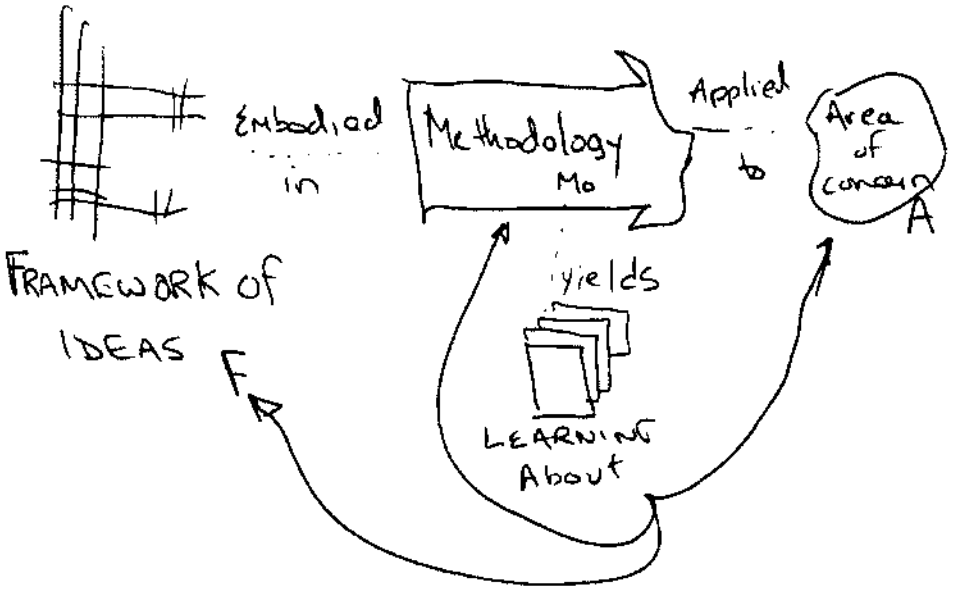


Figure 16: Elements Relevant to Any piece of Research (adapted from (Checkland & Holwell, 1998, p. 23))

Checkland and Holwell describe Figure 16 as "even so simple a model" that "is useful in understanding programmes of research" (Checkland & Holwell, 1998, p. 24). This marks a convenient turning point for the term *model.*

Model is derived from *mode* and is closely related to *mete*, both of which convey the meaning of *to measure* (Skeat, 1993). While first applied to physical items, often smaller scale representations of larger objects, model went through a similar evolution as framework and often came to represent ideas or collections of ideas. Achinstein notes that "the term model enjoys a broad range of uses in the sciences. It may refer to anything from a physical construction in a display case to an abstract set of ideas" (Achinstein.

1965, p. 102). Achinstein focused on theoretical models and proposed four characteristics for them:

> (1) A theoretical model consists of a set of assumptions about some object or system; (2) A theoretical model describes a type of object or system by attributing to it what might be called an inner structure, composition, or mechanism, reference to which will explain various properties exhibited by that object or system; (3) A theoretical model is treated as an approximation useful for certain purposes; and (4) A theoretical model is often formulated, developed, and even named on the basis of an analogy between the object or system described in the model and some different object or system. (Achinstein, 1965, pp. 103-105)

Achinstein develops the differences between theory and theoretical models noting that the theoretical models may exist in advance of the actual theory, the model may provide a usable analysis tool due to the simplifying nature of assumptions made to create models, and the model may assist in the development or refinement of theory.

The use of models, as constructs to explain or represent an idea, concept or system has wide application. Ulrich was working with multiple formal design models for problem solving when he proposed his taxonomic framework (Ulrich, 1977). McLagan and Bedrick, developers of one of the first competency models, used that term, model, to describe the product of their work (McLagan & Bedrick, 1983). Pawlak, inventor of rough set theory, used the concept of a mathematical model of conflict, rather than actual conflict when describing his research and his transmission of the techniques to replicate his efforts (Pawlak, 1984).

The wide use of the term *model* lends itself to problems. The literature discussing these problems is broad and often parallels the successes noted above. Van Gigch (van Gigch, 1989), writing on the demise of OR/MS first heralded by Ackoff (Ackoff, 1979a, 1979b) begins with flaws in problem definition (and by extension model definition) with two sins: "one, they seldom take the "whole problem" into account and two, their closed models do not represent accurately the world where systems are open" (van Gigch, 1989, p. 503). Trying to address the first problem brings one to a set of questions posed by van Gigch as "How far should boundaries be expanded? How many metasystems should be included? What is the optimum boundary? How is it found? Does it exist?" (1989, p. 503). The second problem can also be addressed by expanding the boundaries, but that creates questions formed by van Gigch as "When are the boundaries of this "coherent whole" reached? As a collateral but related question, Which world view should we adopt: the atomistic reductionist view or the holistic global view?" (1989, p. 504) .

Mingers has reviewed developments in Critical Management Science. His treatment of the work of various researchers often uses the word *model.* In relating the efforts of Checkland and Eden in practical management, and to develop soft systems he notes that "They move away from 'objectively' modelling the external world towards modelling peoples' concepts and beliefs about the world in order to generate debate and ultimately agreement about objectives and beneficial changes" (Mingers, 1992, pp. 3-4). He later discusses models of how power is exercised rather than power as a theoretical entity. Referring to Clegg's work *Frameworks of Power*, he writes "Clegg's model of power is two-layered" (Mingers, 1992, p. 8). This foreshadows thoughts on hierarchy between *framework, model* and *system.*

Achinstein discusses the use of models and analogies in developing theory with the aim of being able to differentiate the theory from the model. He proposes five theses to enable scientists to distinguish between the model, the analogy and the theory (Achinstein, 1964). Theories represented as models abound. Altman and Akdere (2008) created a theoretical model on factors inhibiting workplace performance. Bell (2008) investigates Department of Homeland Security leadership, asking if there is a model for leadership. Birleson (1998) investigates if the model of a learning organization is appropriate for improving mental health services. Each of these papers explicitly uses the word *model*, but either a slightly different perspective or different emphasis could have resulted in either a *system* or a *framework*.

Ackoff and Gharajedaghi (1996) address the differences between system and their models, which provides a convenient turning point for this discussion to the topic of system. They began by offering their description and definition of system:

> A system is a whole defined by one or more functions, which consists of two or more essential parts. (1) Each of these parts can affect the behavior or properties of the whole. (2) None of these parts has an independent effect on the whole; the effect an essential part has on the whole depends on what other parts are doing. (3) Every possible subset of the essential parts can affect the behavior or properties of the whole but none can do so independently of the others. Therefore, *a system is a functioning whole that cannot be divided into independent parts. (1996, p. 13)*

Ackoff and Gharajedaghi provide a typology of systems:

There are three basic types of systems and models of them, and a meta-system: one that contains all three types as parts of it (see Table 1).

(1) *Deterministic:* systems and models in which neither the parts nor the whole are purposeful.

(2) *Animated:* systems and models in which the whole is purposeful but the parts are not.

(3) *Social:* systems and models in which both the parts and the whole are purposeful. (Ackoff & Gharajedaghi, 1996, p. 14)

Table 6 Types of Systems and Models (adapted from Ackoff and Gharajedaghi, 1996)

Systems and models	Parts	Whole
Deterministic	Not Purposeful	Not Purposeful
Animated	Not Purposeful	Purposeful
Social	Purposeful	Purposeful
Ecological	Purposeful	Not Purposeful

Each type of system is also carrying a model of that type with it, in the Ackoff and Gharajedaghi typology. Ecological systems contain all three types.

While, this is useful information, and provides an excellent definition of system, it does not bear directly on the taxonomy being created for framework, model and system. We must turn back the clock to an earlier work by Ackoff and the stream of scholarly work that followed it. In a paper titled *Toward a System of Systems Concepts*, Ackoff

outlined a definition of system that applies to this context: "A *system* is a set of interrelated elements … [with] a relationship that holds between each of its elements and at least one other element in the set" (Ackoff, 1971, p. 662). Ackoff extends the concept when he writes:

> An *abstract system* is one all of whose elements are concepts. Languages, philosophic systems, and number systems are examples. *Numbers* are concepts that the symbols that represent them, *numerals*, are physical things. Numerals, however, are not the elements of a number system. The use of different numerals to represent the same numbers does not change the nature of the system.
>
> In an abstract system the elements are created by defining and the relationships of the between them are created by assumptions (e.g. axioms and postulates). Such systems, therefore, are the subject of study of the so-called formal sciences. (Ackoff, 1971, p. 662)

The concept of system advanced by Ackoff figured strongly in Michael Jackson's multi-decade effort to develop a system of system methodologies. Jackson's efforts have been guided by the breadth and scope of the fields that have the word system in their title. While he is not exhaustive in his application, his work can be framed against a larger picture as shown in the rendering of a depiction in Flood and Carson (1993).

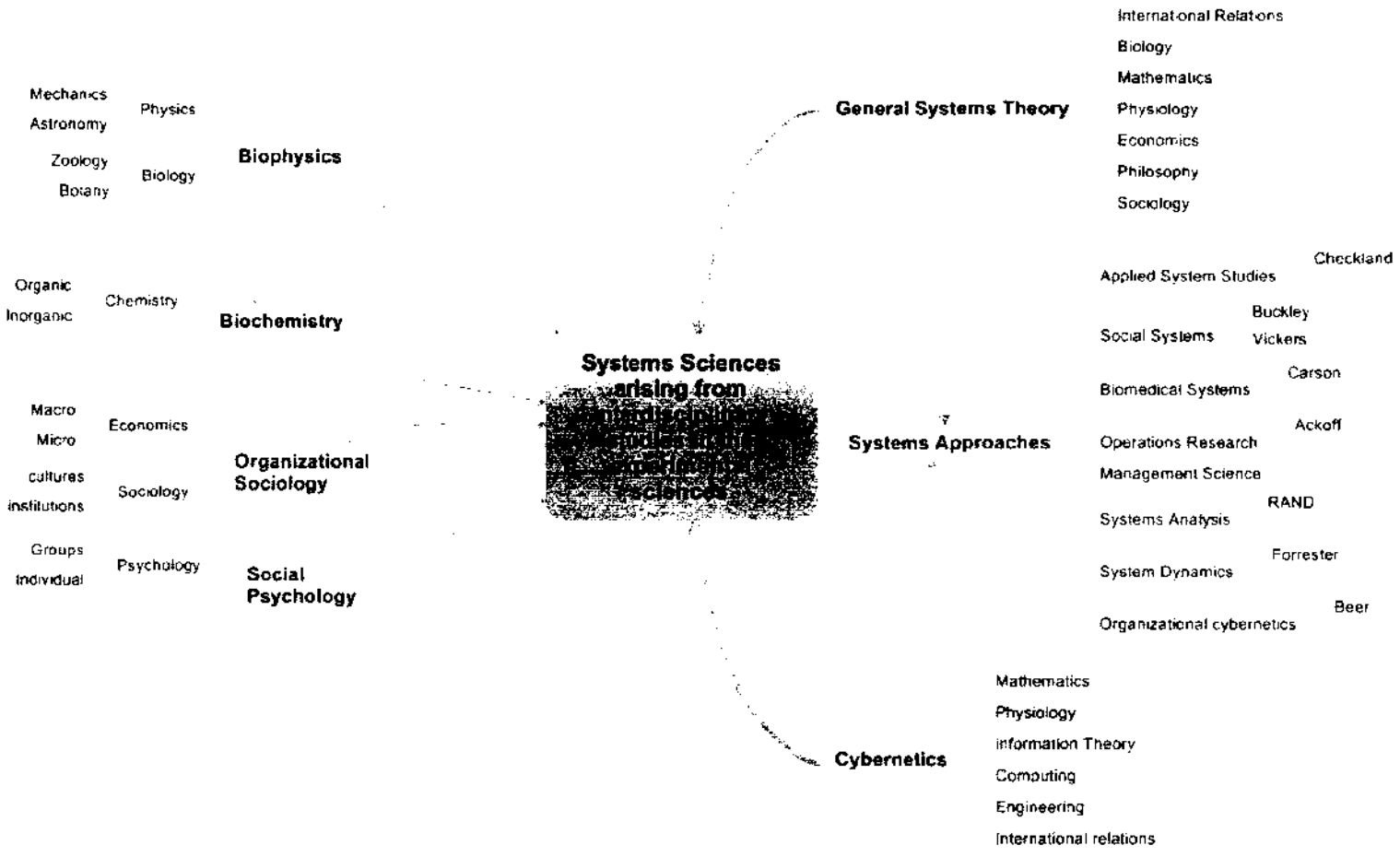


Figure 17: Systems Sciences arising from interdisciplinary studies in experimental sciences (adapted from (Flood & Carson, 1993, p. 7))

The system of systems methodologies framework originally developed by Jackson and Keys, and later refined by Jackson, proposes to provide context to the *problem solver* and contains two perspectives. The vertical axis captures the systems largely defined by complexity, with larger systems with more turbulent conditions, described as *complex*, as compared to smaller systems with stable or largely unchanging conditions that are considered *simple*. The second axis is participants, which are those with an interest in the problem situation as their values, beliefs, and interests start to diverge. The grid is established by the *systems* and *participants* dimensions. This table has undergone a number of revisions as Jackson's thinking has developed over the last several decades. The latest version is based on his discussion in *Systems Thinking: Creative Holism for Managers (Jackson, 2003b)*. Jackson uses *simple* to connote systems that are more mechanistic, have fewer components, and are easier to discern the state and the components. He uses *complex* for systems with more, an undefined term, components and stakeholders, where the states and relationships are harder to discern. In defining the participants, Jackson uses *unitary* for those systems where the leadership may be a sole person or group, but the key characteristic is their alignment on the goal(s) for the system. There is no dissension, at least at the decision maker level, in a unitary participant system. The term *pluralistic* is used to describe a system where there are multiple decision makers, with varying amounts of power or authority and differing goals. However, there is the possibility that one or more courses of action can be agreed upon, possibly as a compromise solution, once it has been elaborated by the problem solvers. The term coercive grew out of the understanding that there may be, in fact often are, systems where there are multiple authority figures with relatively differing power

and authority levels that have differing goals with no possibility of a solution being agreed upon by all leaders. Thus the path chosen is likely to be decided by the authority with the most power, without regard to the effect on the other participants (Jackson, 1990). The *system* consists of the process of discovering the problem, classifying it and then ascertaining the methodology or selection of methodologies likely to assist the *problem solver* in improving the problem situation.

Table 7: Framework for Systems and Participants (Jackson, 2003b, p. 24)

<table>
<tr><td rowspan="3">SYSTEMS</td><td></td><td colspan="3">PARTICIPANTS</td></tr>
<tr><td></td><td>Unitary</td><td>Pluralist</td><td>Coercive</td></tr>
<tr><td>Complex</td><td>Hard Systems Thinking</td><td rowspan="2">Soft Systems Approaches</td><td>Emancipatory Systems Thinking</td></tr>
<tr><td>Simple</td><td>Systems Dynamics
Organizational Cybernetics
Complexity Theory</td><td>Postmodern Systems Thinking</td></tr>
</table>

This representation of system by Jackson is useful for the discussion of framework, model and system and marks an appropriate transition to a discussion of the overlapping uses of the terms.

3.11.1 DIFFERENCES AND OVERLAPS OF THE TERMS FRAMEWORK, MODEL AND SYSTEM

Numerous authors in disparate fields have contributed to the discussion of frameworks, models and systems. Quotes from several that have contributed to the researcher's understanding of the distinctions and overlaps are below:

> "By building on the extant literature that supports the centrality of the literature review, we offer a practical framework from which to analyze the quality of doctoral dissertation reviews of the literature." David N. Boote and Penny Beile (2005, p. 3)
>
> "The map is not the territory." Alfred Korzybski (1958, p. 12)
>
> "To be of any scientific use, the obvious must be reformulated into a conceptual system." Nehemiah Jordan (1968)

As the previous discussion made clear, the terms framework, model and system do not have unique meanings, but like so many others in the English language, they acquire meanings due to the people using them, the groups that those people communicate with, the subjects of the topics communicated amongst the groups and the context within which those groups find themselves.

In the preceding section, we saw overlaps, either explicitly or implicitly in the discussions. If we now return to Jackson's work, and regard Table 7. Note that the researcher (and Jackson) is recursively using the term *system*. It is being used for the *abstract system* comprised of the elements within Table 7 that will enable or assist a problem solver chose a methodology appropriate for his or her problem, but it is also used to describe the milieu in which that problem solver is going to conduct the work, likely a *concrete problem* in Ackoff's terminology. We could just as easily have called the representation in Table 7 either a *model* or a *framework* and reserved *system* to describe the process of selecting the methods or methodologies to engage in the problem solving effort. Further, the process of selecting a methodology is a system!

Checkland and Holwell made the overlap point obvious as well. In their text *Information, Systems, and Information Systems*, they present and define *framework* for our use, but immediately refer to Figure 16: Elements Relevant to Any piece of Research (adapted from (Checkland & Holwell, 1998, p. 23)) as a model, describing the figure as "even so simple a model" yet it "is useful in understanding programmes of research" (Checkland & Holwell, 1998, p. 24).

To complete the circularity, we return to Mingers' discussion of Clegg's work *Frameworks of Power* and the development of different models of power in use (Mingers, 1992). The title uses framework, and develops models of power as a main thrust.

We can also refer to the three quotations at the start of this section. These quotes were extracted from different sources as the synonyms were considered. The researcher believes that they help to answer the question – how are *framework*, *model* and *system* different from each other?

Let us return to Checkland and Holwell and their definition for framework - "a declared-in-advance intellectual framework of ideas, a framework in terms of what constitutes 'knowledge' about the situation researched will be defined and expressed" (Checkland & Holwell, 1998, p. 23).

Jackson's use of *system* connotes action, a way forward for the problem solver. This is a more action oriented perspective than the framework, which can serve as a collection of ideas and be available for research, but Jackson's idiom connotes a more forceful approach.

Both *framework* and *system* in this taxonomy imply a higher level of abstraction than model. When Achinstein's four characteristics of a theoretical model are considered, it appears that the model may be subordinate to either a framework or a system. In fact, Achinstein explicitly describes the relationship when he writes "A theoretical model consists of a set of assumptions about some object or system" (Achinstein, 1965, p. 102). This provides sufficient distinction between *framework, model* and *system* to develop the framework in the axial coding and subsequent phases.

3.12 FRAMEWORK DEVELOPMENT FROM A TYPOLOGICAL PERSPECTIVE

Before discussing the details of the framework development, a short divergence through the concepts of typologies is necessary. The framework is, in essence, a typology, and its structure and language had to be considered before its creation. During the review of the competency literature, the researcher recognized a number of different typologies in the competency field. Thus, the researcher recognized the need to consider the typology of the framework. Before developing a typology, the researcher examined various definitions for typology and how to define typology for this research, thus deciding how to classify competency designs. Typology is part of classification. A typology is usually theoretically based, while taxonomy is usually empirically based. Thus the typology is an applicable method for beginning development of a competency model framework based on inductive theory building. Typologies reflect ontological and epistemological perspectives as well. The positivist orientation is reflected by Rich when he describes typologies:

> The typology is essentially a sophisticated information storage and retrieval system. But the typology is "more than just a filing system, best judged by the ease of retrieval and its general use." (Rich, 1992, p. 758)

Similar positivist views are expressed by Doty and Glick when they describe typologies as "complex theoretical statements that should be subjected to quantitative modeling and rigorous empirical testing...(1994, p. 231)"

They further note that:

> The third term, typology, refers to conceptually derived interrelated sets of ideal types. Unlike classification systems, typologies do not provide decision rules for classifying organizations. Instead, typologies identify multiple ideal types, each of which represents a unique combination of the organizational attributes that are believed to determine the relevant outcome(s). (Doty & Glick, 1994, pp. 231-232)

A more interpretist view is proposed by Tiryakian:

> A typology goes beyond sheer description by simplifying the ordering of the elements of a population, and the known relevant traits of that population, into distinct groupings; in this capacity a typological classification creates order out of the potential chaos of discrete, discontinuous, or heterogeneous observations. But in so codifying phenomena, it also permits the observer to seek and predict relationships between phenomena that do not seem to be connected in any obvious way. This is because a good typology is not a

> collection of undifferentiated entities but is composed of a cluster of traits which do in reality "hang together". (Tiryakian, 1968, p. 178)

Creation of a typology will assist in formulation of theory and may be part of the actual structure of the competency model framework. The next section discusses the considerations in developing the typology that follows later.

3.13 TYPOLOGY CONSTRUCTION

Typologies have been developed in numerous fields, archaeology (Read & Russell, 1996), education (Green & Stone, 1975), competence (Lindgren, Henfridsson, & Schultze, 2004), engineering management(Kern, 2010), and organization theory (Doty & Glick, 1994).

McKinney (1969) provides insights in the development of typologies. He notes that they are "pragmatic reduction and equalization of attributes relevant to the particular purpose at hand (1969, p. 3)", and serve both practical and research purposes. In the research purpose role they "should be constructed to aid in the analysis of specific bodies of data (1969, p. 3)." He also asserts that "typologies must be understood as representative of a pragmatic research methodology and thus subject to evaluation in terms of the accuracy of predictions which result from their utilization (1969, p. 3)". McKinney reviews Lazarsfeld's type construction process:

1. Type construction which includes the development of a "scientific perception" of the regularities, uniformities or relationships which "ought" to obtain in terms of prior research and the theoretical framework which exists for the field under study....

2. Substruction is the second step. The process of substruction is in essence the logical evaluation of the typology. It is the definition of the property-space from which the typology may be empirically produced. (a) Property-space may be defined as a swarm of empirically definable measures or properties which are developed to measure the dimensions of the typological construction. The most familiar example might be a 9 x 80 space defined by the IBM card. (b) This step then implies the construction of indices and other operational definitions of the elements in the typological construct.

3. Data collection is the third logical step in this procedure. At this stage the groups which are to be compared should be defined and the measures should be applied to them.

4. The reduction of the property-space to a set of empirical representations of the initially constructed typology then follows. It is this step in which discriminant analysis is believed to be most helpful. It is at this phase of the analysis that the methodological issues concerning the reality of the types as discrete entities and their relationship to some underlying continuum may best be specified. Particularly with respect to comparative analysis, discriminant analysis is especially adapted to deal with these issues.

5. The final stage of this procedure is the comparison of the constructions developed in the initial state with the empirical approximations which emerge from the analysis (McKinney, 1969, pp. 7-8).

McKinney cautions that since typologies are relatively easy to construct without the rigor of Lazarsfeld's process or some equivalent process, most typologies will not

have gone through an orderly process of inquiry, and while appearing seductively correct, will be reified by the scholars that created them. His suggested mitigation is prevention of an early *freezing* of the typology.

Bailey (Bailey, 1973) provides additional insights in the creation of typologies. Beginning with two goals for typology design "(1) by reducing the number of types so that many cases can be placed in one or a few types; and (2) by reducing the heterogeneity of each type (Bailey, 1973, p. 291)." He quickly introduces the problem that:

> Simultaneous attainment of both goals (1) and (2) is difficult, especially since a typology must be both exhaustive (a cell for every specimen) and mutually exclusive (but not more than one cell for each specimen). Generally the typologist must compromise one or both of these goals. (Bailey, 1973, p. 291)

And he introduces the general rule to deal with the problem "Min-Max Rule: The goal of typology construction is to construct a minimum number of types, each of which displays maximum homogeneity" (1973, p. 291).

Bailey laments that:

> As far as we know, no one has ever provided systematic guidelines to aid typologists in selecting variables. Whether the typologist utilizes a theory to specify his variables or simply examines his specimens and makes an ad hoc decision about which characteristics to use, he would do well to devote careful attention to the problem of selecting variables. This is because changes in the variables used can radically effect the cell frequencies of the types, and can

> also determine whether the types are monothetic, polythetic, or fully polythetic. (Bailey, 1973, p. 306)

As far as this researcher could determine, there is yet no adequate set of guidelines for the selection of variable. As recently as 2012, Collier, LaPorte and Seawright (2012) provide updated guidelines for the development of typologies that are as detailed as Bailey's 40 years earlier in selecting variables. While one might hope that machine learning could assist in typology development, Ahlquist and Breuning (Ahlquist & Breunig, 2012) provide insights into the mechanical (machine) development of model-based clustering (MBC) but find weak results for the single case they examined. They recommend caution in the use of MBC in the development of variables for typologies.

The implications for this research are (1) a typology must have the rigor of Lazarsfeld's process and (2) care needs to be taken in the selection of the variables for the typology. Thus the typology should be viewed as preliminary, requiring review and probable modification as part of the larger research design.

3.13.1 TYPOLOGY REVIEW OF COMPETENCY MODEL LITERATURE

A number of authors within the field of competency models have proposed a number of typologies. Cockerill and Hunt (Cockerill, Hunt, & Schroder, 1995) provide a typology based on the epistemological perspectives present in the workplace, and they "may be labeled(sic) 'traditionalists, 'inventors' and 'scientists'" (Garavan & McGuire, 2001, p. 6). Garavan and McGuire summarize Cockerill and Hunt's typology as:

> For *traditionalists*, the use of competencies is based on the behaviour of the most successful managers or employees in the organisation. They view

> successful job performance in terms of the speed of career advancement. They advocate the use of the characteristics of quickly promoted individuals as the basis for the development of an organisation's competency model. *Inventors* focus on predicting what an organisation and its attitudes will be in the future and consider this to be the most effective way of identifying appropriate managerial behaviours. The outcome of the perspective is the creation of competency lists based on imaginary future organisations. The *scientific* perspective places emphasis on identifying, measuring and developing behaviours which will distinguish individuals who continuously outperform others. This perspective advocates that there are generalizable high performance competencies that appear to distinguish high performance from average performing employees (Cockerill, et al., 1995, p. 6).

Hoffman develops a typology based on whether the competency model is output focused or input focused and whether it has individual or corporate uses. In the output focused environment, "*competencies are outputs in the sense that they are performed as a consequence of training or other learning programs (T. Hoffmann, 1999, p. 280)*". In the input focused environment, "[i]*nputs refer to the content of the training and education needed by learners in order to become competent performers (T. Hoffmann, 1999, p. 280).*" Hoffman concludes with a discussion of the confusion over the meaning of competency and defines the unifying concept as an effort to "*improve human performance at work*" (T. Hoffmann, 1999, p. 285).

Rothwell and Lindholm (1999) describe three of the most common methodologies used to create competency models. This listing comprises another perspective on

typology. Their list is: (1) the borrowed approach, (2) the borrowed-and-tailored approach and, (3) the tailored approach. They discuss the advantages and disadvantages, primarily from two perspectives: cost and efficacy. The tradeoff being made by the organization as it moves up the cost scale is hopefully better efficacy. However, Rothwell and Lindholm note the paucity of research focused on determining the improved efficacy with rising cost as the fraction of the competency model that is tailored is increased.

Kurz and Bartram review four other typologies associated with competencies while seeking to develop Holland's World of Work model (Kurz & Bartram, 2002). Brophy and Kiely develop a different competency typology while researching Irish three star hotel staff competencies (Brophy & Kiely, 2002). Vidou et al. (2006) develop a competency typology while exploring Communities of Practice. Rock and Garavan explored competencies within a developmental relationship typology (Rock & Garavan, 2006).

The typologies that have been reviewed provide guidance to the researcher on the different perspectives available to the researcher. The implications and model chosen by the researcher are discussed in the next.

3.13.2 TYPOLOGY IMPLICATIONS FOR THIS RESEARCH

When developing the competency model framework, the typological perspective will assist in determination of the language of the framework. With three possible models to choose from, the input based model, the output based model and the outcome based model, selective coding and thematic development were the phases where a framework in outcome language was developed.

Reflecting on the very systems theory propositions that form the basis for the new competency model framework, the propositions of holism and communication push to the fore. This competency model framework is being constructed to capture the whole system, and communicate meaning most clearly. This lead the researcher to focus the competency model framework on the outcome based model, and use that perspective during the selective coding and framework construction phases.

3.14 SUMMARY OF THEORY BUILDING PERSPECTIVE

This portion of Chapter 3 has focused on the methodological approach to theory building. It began with an explication of the researcher's epistemological and ontological perspectives, which assists understanding of the perspectives brought to the task of translating a research question into action. An examination of the axiological perspective served to heighten the researcher's perspective on validity and reliability. Next was an examination of several theory building methods that might support the overall methodology of Discoverer's Induction. Grounded theory was selected as the most suitable. Following this was a discussion of the possible starting points for the literature data selection and the logical starting point for this research with Adams, et al. (2014). A detailed discussion of Whewell's Discoverer's Induction follows and sets the stage for using grounded theory as the method for data collection and analysis in preparation of actual framework creation. This establishes the groundings of the framework and suitable transition to a discussion of Case Study Methodology.

3.15 RESEARCH DESIGN OF THE CASE STUDY

Eisenhardt (1989) presents an earlier model of theory building case study approach which largely aligns with Yin (2009). The use of case study as a research method requires thoughtful work before selection. Yin describes a six step iterative process for developing case study research designs that is displayed Figure 18. This chapter will detail the specific application of the six step process to this research effort. The case study portion of this research focuses on answering the question: *What results from application of the systems theoretic competency model framework to analyze a competency model in an operational setting?*

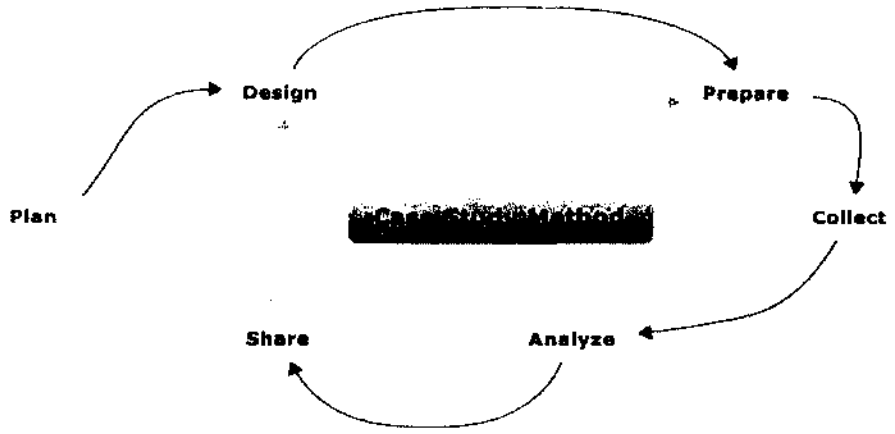


Figure 18: Case Study Process (adapted from Yin, 2009, p.1)

3.15.1 PLAN

The first step is development of the *plan*. Part of the plan step is a determination that case study research is an appropriate approach. Case study research is an appropriate method to answer this question for the following reasons (Yin, 2009):

- The question is framed as a "what" question, but it is exploratory in nature. This indicates the use of case study as a viable method;
- There is not a requirement to control behavioral events. Case study remains a viable option as a method in this situation, and finally;
- The use of an extant, existing competency model as the target of the analysis for the competency model framework indicates a very contemporary temporal aspect. Yin notes that "case study is preferred in examining contemporary events, but when the relevant behaviors cannot be manipulated (Yin, 2009, p. 11)."

Bailey (1973) provides a discussion of the relationship of case study to typology development. The case study may be used as part of a heuristic typology development which would supplement the competency model framework developed in the inductive portion of this research.

3.15.2 DESIGN

The next important step of the case study research *design* is the identification of the case and establishing the logic of the case. This step includes five components described by Yin (2009, p. 27) as especially important:

1. A study's questions;
2. Its propositions, if any;
3. Its unit(s) of analysis;
4. The logic linking the data to the propositions; and

5. The criteria for interpreting the findings.

The details of each these steps is covered in the applicable portion of Chapter 4, while these general ideas serve as an appropriate time to transition to the study question.

3.15.3 STUDY QUESTIONS

This research has identified the question to be answered as: *What results from application of the systems theoretic competency model framework to analyze a competency model in an operational setting?* The first element of the research developed a systems theoretic based competency model framework. The case study examines an "espoused competency model", based on the documents provided by the organization, rather than the "in use competency model" represented by what the organization's members actually do to execute the espoused model. The question for this section of the research depended on successful completion of that framework, and gives rise to the next component, the study propositions.

3.15.4 STUDY PROPOSITIONS

During the design phase, in the absence of the completed framework, only a representative or partial set of propositions could be constructed. Yin reinforces this expectation by noting that this step "will move you in the right direction" (Yin, 2009, p. 28). Several sample propositions expected to appropriate for this research included:

- Is the competency model over-determined or under-determined? (design axiom)
- Does the competency model reflect a holistic or reductionist approach? (contextual axiom)

- Does the competency model promote sub-optimization? (operational axiom)

The competency model framework development spurred revision of the propositions. The propositions that were used were developed as a function of the competency model framework and are contained in Appendix D.

3.15.5 UNITS OF ANALYSIS

This component of the case study depended in part on the competency model that was made available. The domain of management theory is wide, with applications in many different businesses. A detailed set of requirements for a competency model suitable for a case study was developed. This is discussed in detail in Chapter 4. While three target competency models had been identified and discussions initiated with those three organizations, the targets were revised after formally detailing the requirement. All targets remained defense related, with representative organizations in both government and private sector. These organizations traditionally treat their personal practices as privileged information, and it became necessary to promise anonymity to secure access. The negotiations to actually use just one competency model took a number of months, and these occurred in parallel with the inductive framework building phase of this research. The discussions will include the eventual publication of the case study and its answers to the research question: *What results from application of the systems theoretic competency model framework to analyze a competency model in an operational setting?* The discussions on publication included the topic of gaps as well as identification of the organization. Based on previous relationships with these organizations, access to the competency model for the management sphere of operation was granted and allowed for a clear definition of the *unit of analysis.* The organization requested that the data be

anonymized as part of the conditions of providing their model for analysis. The researcher has respected this request.

3.15.6 LINKING DATA TO PROPOSITIONS AND CRITERIA FOR INTERPRETING FINDINGS

Yin describes five ways of "linking data to propositions: pattern matching, explanation building, time-series analysis, logic-models and cross-case analysis" (Yin, 2009, p. 34). The competency model is unlikely to have time-series data eliminating that particular method, while only one case was examined eliminating the cross case analysis method. Logic-models are better suited to a "complex chain of events over an extended period of time" (Yin, 2009, p. 149) which is not expected in this case. Pattern matching and its subset explanation building remain as ways to link data to propositions. Yin notes the difficulty of explanation building as a technique, but that would be the very goal of this case study. Tuan notes that ambiguity prevails in many borderline cases and rigidity in classification may depart from reality (Tuan, 2010).

Yin notes that explanation building has not been well documented, but provides a description that the "eventual explanation is likely to be the result of a series of iterations:

- Making an initial theoretical statement or an initial proposition about policy or social behavior
- Comparing the findings of an initial case against such a statement or proposition
- Revising the statement or proposition
- Comparing other details of the case against the revision

- Comparing the revision of the facts of a second, third or more cases
- Repeating this process as many times as needed. (Yin, 2009, p. 143)

For this research, the first four steps of the iterative process were accomplished within this case study.

Yin places *theory development* in this portion of the research design. In the present research, the systems theoretic competency model framework was already developed (Yin, 2009).

The competency model framework provides a theory of what elements should be present in a competency model, as well as how to develop new competency models. The case study provides a validation of the theory (Eisenhardt, 1989).

3.15.7 CRITERIA DEVELOPMENT

When the case presents numerical data, it is possible to develop statistical tests to ascertain the validity of the criteria used for interpreting the case study data. When significant statistical data is not available, Yin (2009) recommends the identification of rival theories as important contrasts to the proposed theory. Numagami proposes the concept that internal validity and construct validity depend on the existence of invariant laws that can be discovered. He further proposes that management science has few invariant laws and the very role of people in management lessens the potential for an invariant law to exist. He proposes reflexivity – the ability of the agents to reflect upon the situation and change their strategies – as a technique to be applied to the case study itself (Numagami, 1998). The ability to count and measure as typified by the ordinal grading scale improves the ability to explain (Tuan, 2010).

3.15.8 PREPARATION

The third step in the design is *preparation.* Yin describes a list of commonly required skills to conduct a case study as follows:

- A good case study investigator should be able to ask good questions – and interpret the answers.
- An investigator should be a good "listener" and not be trapped by his or her own ideologies or preconceptions.
- An investigator should be adaptive and flexible, so that newly encountered situations can be seen as opportunities, not threats.
- An investigator must have a firm grasp of the issues being studied, even if in an exploratory mode. Such a grasp reduces the relevant events and information to be sought to manageable proportions.
- A person should be unbiased by preconceived notions, including those derived from theory. Thus a person should be insensitive and unresponsive to contradictory evidence (Yin, 2009, pp. 68 - 69).

The five bullets above include a key underlying message. Qualitative research seeks validity, which often rests on a positivist approach. Rolfe (2006) proposed that if there "is no unified qualitative research paradigm … each study is individual and unique, and that the task of producing frameworks and predetermined criteria for assessing the quality of research studies is futile" (Rolfe, 2006, p. 304). A key component of the preparation for a specific research design is development of a protocol. Yin describes the

protocol "as a major way of increasing the reliability of case study research" (Yin, 2009, p. 79) with the following sections:

- an overview of the case study project...,
- field procedures...,
- case study questions ..., and
- a guide for the case study report.... (Yin, 2009, p. 81)

For each section of the protocol, Yin provides detailed guidance and suggestions for the researcher. These suggestions assisted the researcher in preparing the protocol for the case study.

The protocol serves the researcher during the *collection* component of the case study. Yin identifies six sources of data for the case study: documentation, archival records, interviews, direct observation, participant-observation, and physical artifacts. Documentation, in the form of the extant competency model, will be the core material in this case study. Yin identifies the following strengths: stable, unobtrusive, exact, broad coverage, and the following weaknesses: retrievability, biased selectivity, reporting bias and access (Yin, 2009). The protocol will include measures to overcome the weaknesses and improve the reliability of the case study. Yin also discusses several principles to improve data collection techniques. These include creation of a case study database and maintaining a chain of evidence. The case study database "dramatically increases the reliability of the entire case study" (Yin, 2009, p. 118). The chain of evidence also increases the reliability of the study (Riege, 2003). All the effort on data collection improves the next component, analysis.

3.15.9 ANALYSIS

The previous components have laid the groundwork for *analysis.* While there are analytic tools available, the volume of data often overwhelms the researcher. Miles and Huberman (1984b) provide a wide number of suggestions for the researcher to manipulate the data. These include putting the data into arrays, making matrices of different categories, creating data displays, tabulating the data, such as frequency of events, then examining the tabulated data or developing some temporal scheme. As discussed earlier, the analysis links data to propositions. The research is expected to develop an explanation building form of pattern building. Yin describes four principles to provide the highest quality research. These principles are as follows:

- attend to all the evidence
- address all major rival interpretations
- address the most significant aspect
- use prior, expert knowledge (Yin, 2009).

The analysis addressed all four aspects formulated by Yin, and sets the stage for the final phase, sharing.

3.15.10 SHARING

Completion of the analysis component sets the stage for *sharing*, the final component. While the discussion has been linear to date, recall that the process was called iterative. This is partly due to the researcher starting components before completing earlier components, and partly due to explicit movement between components as knowledge is uncovered that requires returning to an earlier component.

Yin recommends beginning the composition of the report early in the process. Beginning the report early allows the intended structure of the report to be iteratively improved as other case study components are accomplished. This also allows the researcher to address the situation if the new theory should be disconfirmed by a rival theory. This also helps prevent the researcher from ignoring data, a form of bias. Another advantage to starting early is that it will allow reviewing the case study report by others. Review of the case study by others is a strategy that improves the validity.

3.16 CRITICISM OF THE CASE STUDY METHOD

Before proceeding to the details of the case study validation, a discussion of weaknesses in the case study method identified by scholars is appropriate. The discussion will seek to inform the researcher and improve the validity and reliability of the case study work. This is an evolving discussion, with new lessons learned and disseminated frequently. Case Study Method has experienced similar discussions of validity and reliability. Even leading researchers in the field acknowledge the criticisms as long standing, but often offer strategies to overcome those concerns (Chalofsky, 1996; Eisenhardt, 1989; Stake, 1995; Yin, 2009). Yin, in particular, has offered a number of strategies for improving the validity and reliability of the case study method. Yin frames the strategies within discussions of several common scholarly criticisms of case study method. The first surrounds early definition of case study. Case study was viewed as an exploratory stage prior to some other type of research method. The researchers reporting on their study provided little detail about the case study portion of the research. Yin cites work done by Platt on early ethnographic work that focused on *participant observation* data collection techniques (Platt, 1992). The lack of rigorous texts describing how to do

case study has largely been overcome. Additionally, the use of case study teaching methods may have been confused with case study research methods. Case study teaching methods may not have exhibited the rigor needed to overcome author or researcher bias. Scholarly reference works like Yin's *Case Study Research: Design and Methods* (Yin, 2009) have provided clear guidance for the conduct of case study research.

A second concern noted by Yin is the basis for scientific generalization. Traditional scientific experimentation is really based on single experiments, but the nature of case studies often limits the number of samples. Rather than using *statistical* generalization resulting from scientific experimentation, case studies must be carefully selected to permit *analytic* generalization (Yin, 2009). This improves external validity or transferability. The site for this case study was carefully selected to allow analytic generalization as discussed later in this chapter.

A third complaint is the perceived required duration and resulting mass of documentation for case study research. As case study method has matured, duration and massive documentation have become more manageable (Yin, 2009). This improves internal validity or credibility, in a manner similar to the data representation advice provided by Miles and Huberman. In this research effort, the use of Nvivo software made the management of the data reasonable and aided in the analysis.

Finally, Yin notes the dominant perspective on the use of randomized field trials and the inability of case study research to produce the same efficacy in connecting a *treatment* to an *effect*. He notes the complementarity of case study research and their

ability to answer *how* and *why* questions compared to the experimental approach (Yin, 2009). Again, this improves the credibility of the case study method.

3.17 MEASURES TO IMPROVE VALIDITY AND RELIABILITY

Throughout the earlier sections of this chapter, discussions included steps and measures to improve validity and reliability. This section collects those measures to provide clarity on the topic. Strauss and Corbin (1998), Miles and Huberman (1984b, 1994), Yin (2009) and Eisenhardt (1989) helped guide this section. Eisenhardt (1989) offers a process for building a theory from case study research with activities at each step of the process with a parallel explanation of how that process improves the goodness of the case study as research. This process assisted in the compilation of Table 8, and it represents the specific steps taken to improve validity and reliability for the entire research problem.

Table 8: Measures to Improve Validity and Reliability (adapted from (Eisenhardt, 1989, p. 533)

Step	Activity	Reason
Starting out	Theoretical sensitivity	Alerts researcher to possible biases, already determined theories
Selecting Literature	Neither theory nor hypotheses	Retains theoretical flexibility
Enfolding literature	Comparison with conflicting literature	Builds internal validity, raises theoretical level, and sharpens construct definitions
	Comparison with similar literature	Sharpens generalizability, improves construct definition, and raises theoretical level
Crafting Instruments and Protocols	Development of protocol for each phase	Strengthens repeatability
	External Review	Provides assessment of researcher bias and missing data elements from open coding
	Triangulation	Strengthens grounding of theory by triangulation of evidence
Shaping Theory	Iterative tabulation of evidence for each construct	Sharpens definition, validity, and construct
Reaching Closure	Theoretical saturation when possible	Ends process when marginal improvement becomes small

Reflection on the material in this section impelled the researcher to build researcher aids to be used during the research. Some of those aids were completed early, but others were developed at the point of application. A second action was to implement a requirement for the schedule to include periods of *reflexivity* where the researcher reviewed the changes that were needed to be made along the path. This was very helpful along the way, and the reflexive periods actually sped the research along by forcing the

researcher to contemplate the path already taken and where the path would lead going forward. This concludes the discussion of the strategies that were used to enhance validity and reliability.

3.18 SUMMARY

The case study provides a real-life application of the competency model framework to an extant competency model. The case study application of the competency model framework illustrates shortfalls in the existing competency model allowing the owners of the model to make alterations or transformations based on a systems theoretic approach. The case study also demonstrated the regions of strength in the extant competency model based on systems theoretic framework.

This chapter has developed the perspectives of the researcher on the epistemological, ontological and axiological axes, allowing the selection of methodologies appropriate for the research questions. In preparation for the framework construction, the very definition of a framework has been explicated, and the use of typologies has been explored. The case study methodology has been reviewed, as well as a discussion of the weaknesses and strengths. A detailed discussion of each of those methodologies has been provided and serves as a foundation for the next chapter where the details of the research design are discussed.

4. RESEARCH DESIGN

This chapter discusses the research design, details of the inductive framework development using grounded theory methods and the details of the case study application. The framework building using inductive methods is explicated including literature data search, open coding, axial coding and selective coding ultimately leading to the production of the competency model framework. A discussion of potential typologies is included to illustrate the choices that can be made in building a framework, once the description of the framework construction is complete; there is a transition to the details of the case study using the newly developed competency model framework to assess an extant competency model. The case study application serves as a face validation of the new framework, indicating the ability of the framework to offer utility when applied to an operational setting.

4.1 THE RESEARCH DESIGN

The researcher used grounded theory as the overall structure for the inductive framework development, supplemented by the concepts of the much older *Discoverer's Induction* of William Whewell (1840). grounded theory has well developed phases, beginning with data collection and axial coding, followed by development of categories through axial coding and subsequent development of themes through selective coding (Strauss & Corbin, 1998).

This leads to the definition of the framework, the ultimate product of this research. Figure 19 depicts the grounded theory phases. Each numbered arrow depicts an iterative process within the phase. A short description of each process is provided here. In

Open Coding, the data are divided into segments and then scrutinized commonalities that reflect categories or themes. Data are examined for properties that characterize each category. In Axial Coding, interconnections are made among the categories and subcategories. In Selective Coding, the categories in their interrelationships are combined to form a storyline that describes what happens. And finally a theory, in the form of a verbal statement, visual model, or series of hypotheses is offered to explain the phenomenon in question (Strauss & Corbin, 1998).

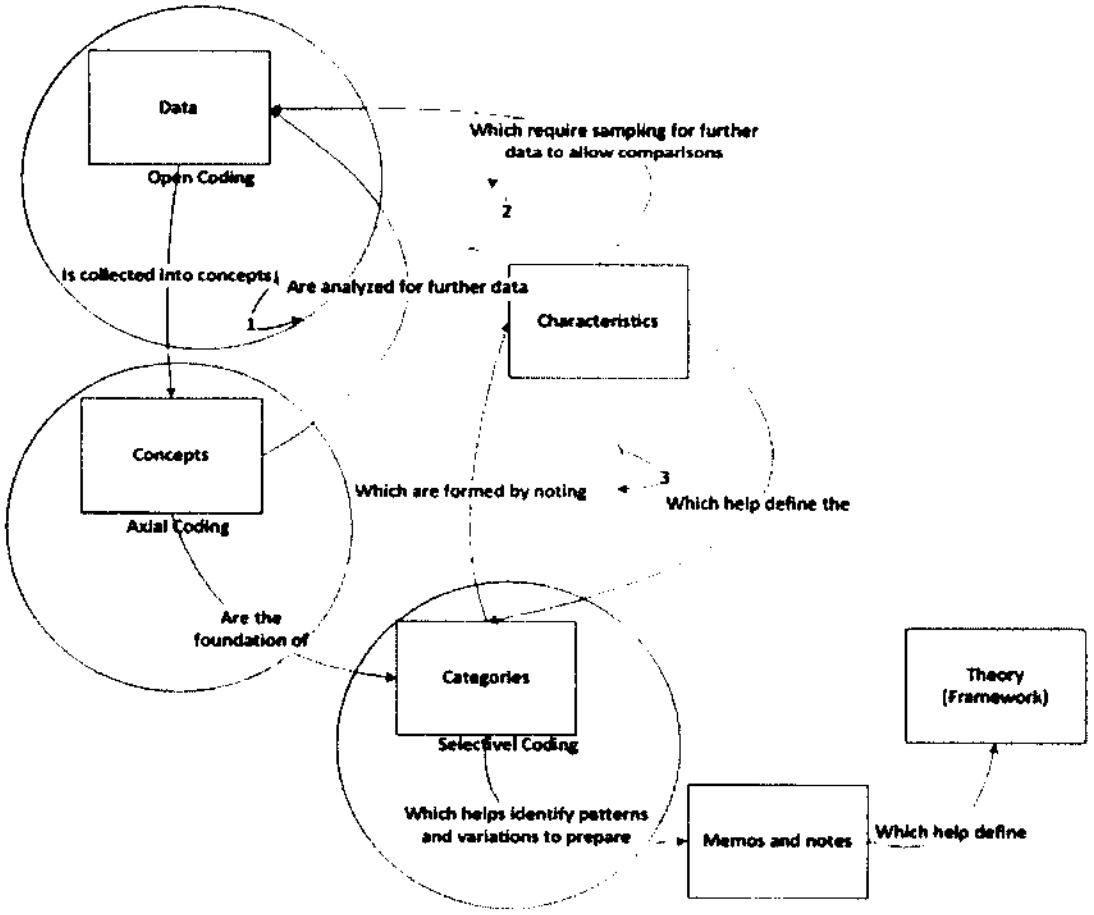


Figure 19: Grounded Theory Flow with Iterative Paths

The detailed descriptions of the coding phases, as well as the transitions and feedback loops will be discussed in the following sections.

4.2 DESCRIPTION OF LITERATURE DATA COLLECTION AND OPEN CODING PROCESS

The literature data collection and open coding process formed a coherent whole. The literature data collection began with the journal article entitled *Systems Theory as the Foundation for Understanding Systems* (Adams, et al., 2014). This source document presents systems theory from the perspective of defining systems theory in terms of axioms and propositions. This source is consistent with the literature in the field and offers an organization and common language for the field. The paper's authors propose a set of seven axioms, each with supporting propositions ranging in number from two to seven. The collection of 30 propositions formed the first set of codes for the grounded theory open coding process. Each of the 30 propositions is preliminarily defined by a seminal document, either a book or scholarly paper. Using the guidelines provided by Saldaña (2013), a codebook was constructed to assist in clarifying the meaning of each code identified in the starting journal article. The codebook consisted of one codebook page per code with standard questions designed to frame the researcher's meaning of the code word. In most instances, the short definition provided by the authors was retained. In several instances, the definition was expanded. As the codebook page was developed, a search of online databases for the code word was conducted. The first saturation point was determining the number of sources required for the open coding (Strauss & Corbin, 1998). This process followed the guidance of Strauss and Corbin (1998) in that "no new information seems to emerge (p. 136)(p. 136)." terminating the search for more sources.

A sample of a portion of a codebook page is presented in Figure 20. The complete set of codebook pages is contained in Appendix A.

Once the codebook page was drafted and the sources collected, open coding began. Each source document was coded for all 30 propositions at a single pass. As the database began to fill with coded documents, some codes began to appear to be saturated. Later documents were only coded for saturated codes when a new concept, perspective or relationship to other codes was identified. This represents the second saturation point for coding - when no additional material or perspectives were gained from the literature. Three categories were identified during the coding process. These categories are (1) temporal relationship (or *Past-Now-Future:: Future-Now-Past*), (2) performance (or Potentiality, Capability and Actuality) and (3) leadership. These three categories repeatedly occurred in the literature, despite never being a search term.

Axiom: Centrality Proposition: Emergence	
Short Description	For all things that have more than one part, and of which the sum is not like a heap, but a whole that is something over and above the parts, have something that is responsible for them; since among the bodies, the cause of the being -one of some of them is contact, and of others stickiness or some other attribute of that sort. (Sachs, 1999, pp. 163-164)
Detailed Description	One group of ideas are manifest in the statement that emergent properties are "novel" and "unpredictable" from knowledge of their lower level bases, and that they are not "explainable" or "mechanistically reducible" in terms of their underlying properties. (Kim, 1999, p. 5) The second group of ideas I have in mind comprises the specific emergentist doctrines concerning emergent properties, and, in particular, claims about the causal powers of the emergents. Prominent among them is the claim that the emergents bring into the world new causal powers of their own, and, in particular, that they have powers to influence and control the direction of the lower-level processes from which they emerge. (Kim, 1999, pp. 5-6)
Inclusion Criteria	Can the properties of the *level of interest* be predicted from an analysis of the level below? If not, then emergence has occurred.
Exclusion Criteria	Can the properties of the *level of interest* be predicted from an analysis of the level below? If so, then emergence has not occurred.
Typical Exemplars	Humans, a sphere (Aristotle's examples)
Atypical Exemplars	Not Required
Close, but No	A heap of sand

How is the axiom being discussed?	Axiom was not invoked by Aristotle
How is it related to the proposition?	Directly describes the proposition of emergence by the existence of a whole that is more than the sum of its parts, as opposed to a whole comprised merely of its parts (a heap).

Figure 20: Sample Codebook Page for Proposition of Emergence

While only three new categories were identified, the concept of discinyms identified words in disparate fields that have very similar or identical meanings was addressed. Discinyms is a neologism developed by Troncale (2009) to capture the problem that arises when disparate fields use dissimilar terms for concepts that have the same meaning. This becomes an obstacle to representatives from disparate fields having

conversations about those ideas (Troncale, 2009). One example is the term *darkness* developed by Cilliers (1998), where two common discinyms are *incompressibility* (K. A. Richardson & Tait, 2010) and *ignorance* (R. Geyer, 2003). When discinyms were identified, the coding was expanded to include those textual portions of the applicable references. Early proponents of systems theory had thought to overcome this problem by establishing a common language, with unified definitions for the terms (Bertalanffy, 1953). Researchers like Bertalanffy sought to take advantage of the concept of isomorphy to identify the common principles and then use common terms. Troncale's neologism puts that idea to rest within systems theory.

An initial memo was created upon completion of coding for each of the 30 nodes. Similar to the process of developing the codebook pages, and assessment was conducted of the coded literature compared to the initial codebook definition to determine if the meaning of the code had changed by the coding of the literature. Several codes were given slightly expanded meanings based on the literature coding. A sample memo is presented in Figure 22. This phase consisting of literature data collection, codebook page creation and open coding is portrayed pictorially in Figure 21.

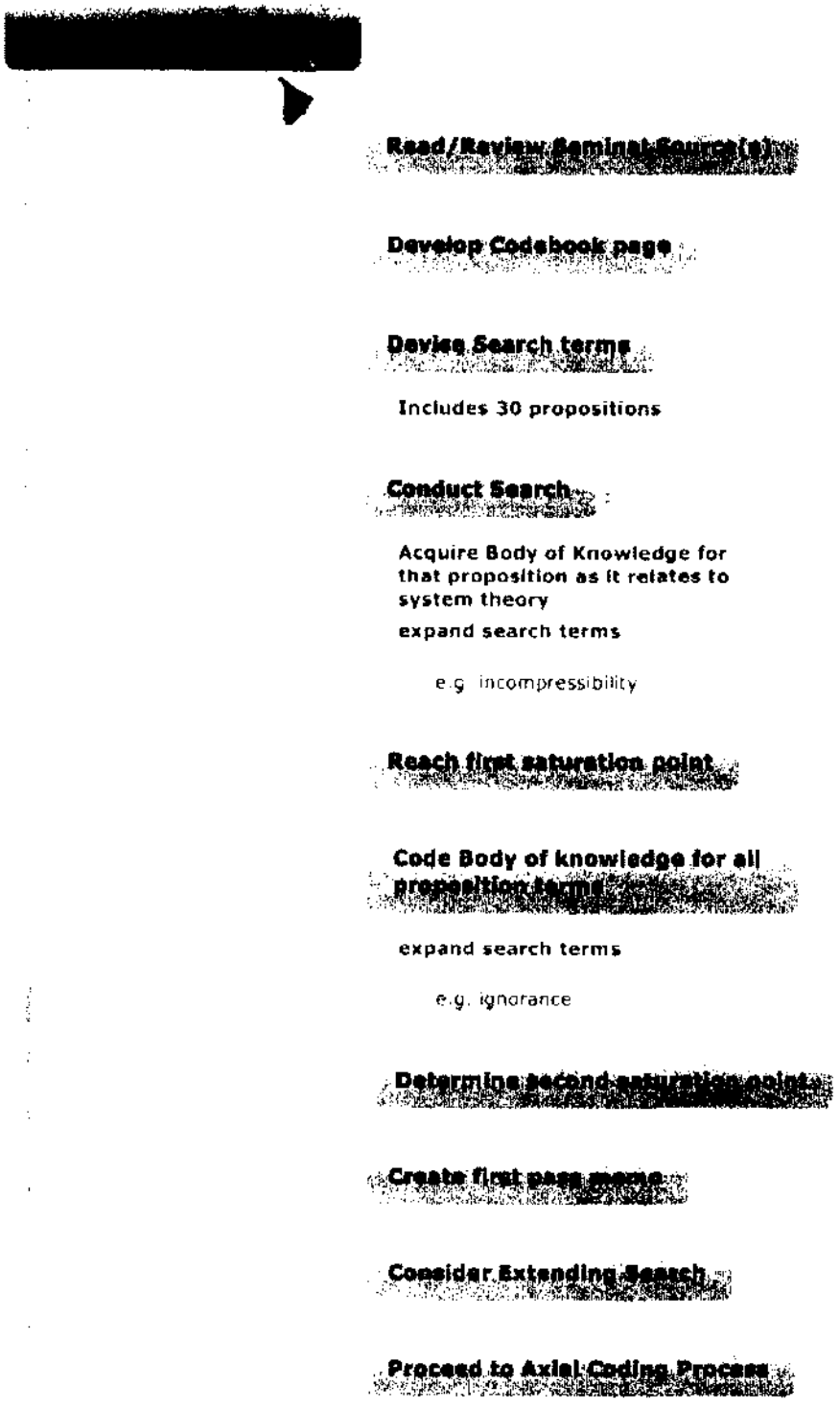


Figure 21: Literature Data Search, Codebook Page Creation and Open Coding

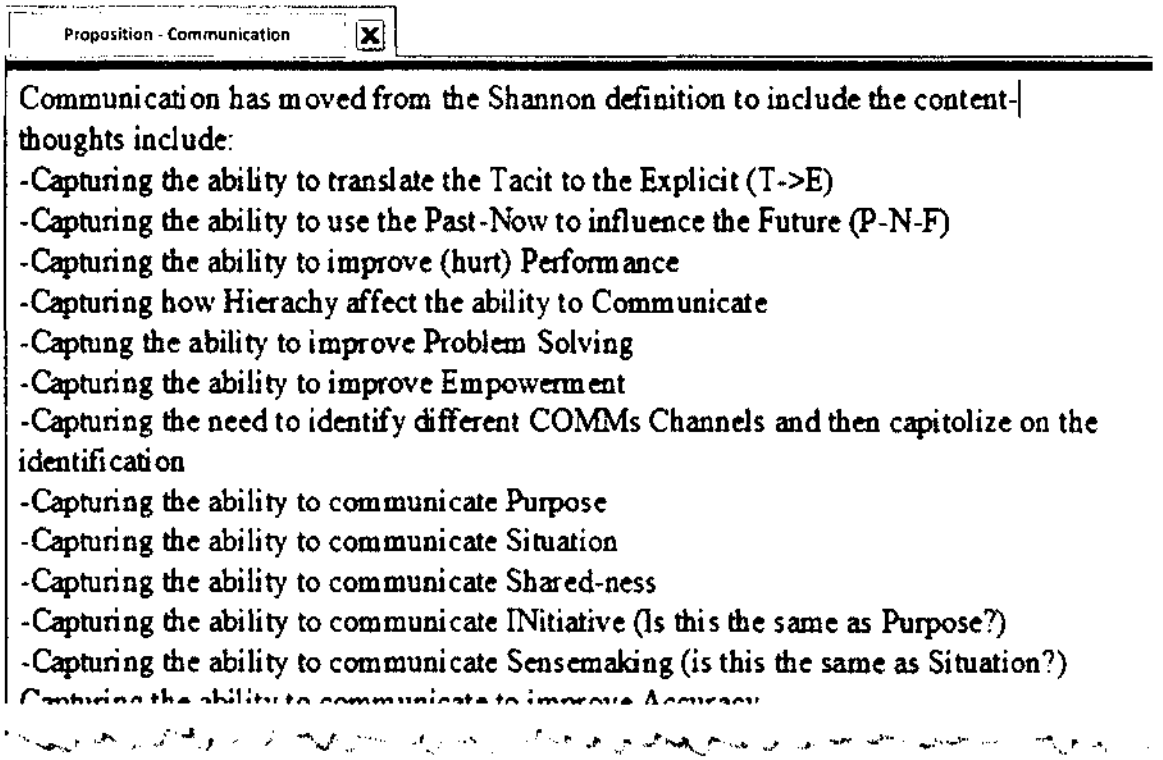


Figure 22: Sample Nvivo Memo for Proposition (Decolorized)

As saturation was reached, open coding was completed for all 30 proposition nodes. Before proceeding to the axial coding, an expert review was conducted by two selected experts. Their direction, role and results are discussed in the next section.

4.3 THE EXPERT REVIEWER AND THE ROLE OF THE REVIEW

The review conducted by the experts is meant to ensure *representativeness* of the literature data collection selected for the study. The collected literature data set served as the foundation for the open coding. It is the empirical data that forms the foundation for developing the framework. It spans a wide range of fields, concepts and time. Miles and Huberman (1994) note a number of assumptions and errors that researchers can make

easily with their data. They discuss the tendency to prefer confirming data, even in the face of more numerous disconfirming data.

The use of outside experts, independent from the researcher, is meant to assist in improving validity by validating that the information selected by the researcher is sufficient as a foundation for the inductive development of the framework. The experts selected were chosen based on their education, experience and personal involvement in previous work involving systems theory. Each expert met the following criteria: (1) has an earned Ph. D. systems theory related field; (2) has published over 20 articles in scholarly literature on topics involving systems theory; (3) has spent over 10 years in research relating to systems theory; and (4) has taught graduate level course in systems theory curriculum. The working copies of the codebook sheets as well as copies of the articles collected and coded were provided to each expert.

4.3.1 SCHEMA FOR THE EXPERT REVIEWER

The wide-ranging nature of systems theory requires the inclusion of scholarly literature from numerous fields including management, organizational design, hydrology, psychopathology, operations research, software design and development, and systems theory itself. The literature data search included databases with appropriate scholarly journals in the aforementioned fields.

The expert reviewers were provided with a number of questions to guide their review of the literature data collection. These questions were designed to elicit specific feedback on the scope and appropriateness of the literature data collected for the

induction. An example of the question is provided in Figure 23. The results are contained in Appendix A - Peer Review of Literature Data Collection.

		Grading Selection				
Section: *Research Design: Qualitative*		UN	AD	VG	EX	Provide reasoning and comments on grading
The use of qualitative research was the best fit for the problem		☐	☐	☐	☐	
The specific qualitative research technique used was appropriate to the problem		☐	☐	☐	☐	
	Grounded Theory	UN	AD	VG	EX	Provide reasoning and comments on grading
	The feature or characteristic of interest was identified	☐	☐	☐	☐	
	The study population possessed the feature or characteristic of interest	☐	☐	☐	☐	
	The methods of data collection were disclosed and were adequate	☐	☐	☐	☐	
	Additional Comments					

Figure 23: Sample Expert Reviewer Question Sheet

4.3.2 RESULTS OF THE REVIEW

The researcher expected that the experts would (1) provide comments on the selected literature data set, and (2) potentially recommend additional scholarly articles from the literature that would add perspectives or depth to increase the usefulness of the framework.

The remaining pages of Appendix A are used to capture the comments of the expert reviewers which are part of the literature data set, as well as any recommendations of additional literature sources that were included directly in the literature data set for the inductive framework development.

4.4 AXIAL CODING

Upon completion of the open coding phase, the researcher contemplated the data with an eye to understanding how to construct a framework from the mass of data. Over 500 documents had been initially coded with 435 coded to 33 nodes with nearly 5000 data elements supporting those 33 nodes. Corbin and Strauss discuss axial coding as a collection of those data elements into a new perspective. The questions were *what perspective?* and *how to align the data to the perspective?* (Strauss & Corbin, 1998)

An early perspective was the relationship between all the nodes to each other. Nvivo data was exported to Excel representing the *cross-connections* between the nodes. The cross connections are represented in matrix form showing the number of times each pair of nodes is references in common. Three nodes stand out visually, and mathematically as dominating the cross-connections: Leadership, Performance (Actuality, Capability and Potentiality) and Temporal Relationship. These three nodes become the first three categories. Much later in the research, these three categories became Personal Capability Categories. A simple sum of each column (less the cell representing the node paired with itself) showed that these three nodes were mathematically distinguished from the remaining 30 nodes. Table 9 represents the cross-connection data from the data set of coded literature. This analysis was helpful in establishing one potential axis of a framework based on those three categories.

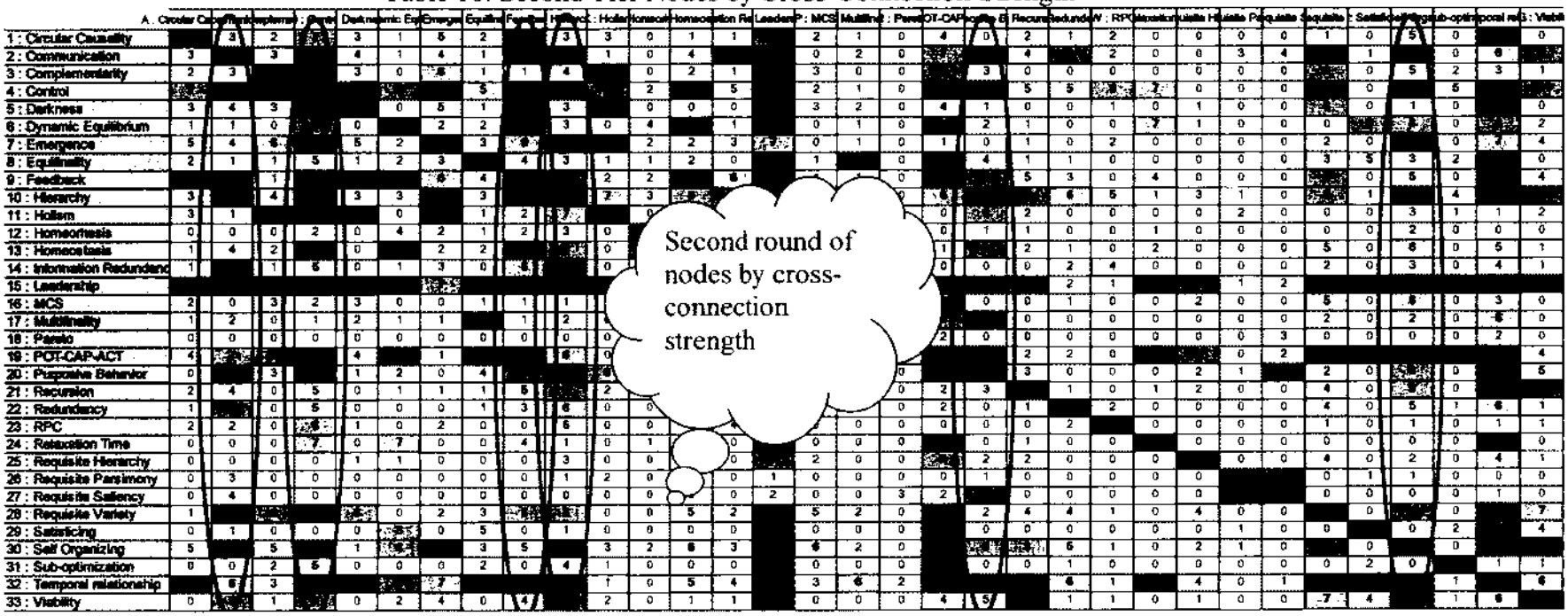
Once the first potential framework axis was established, the question shifted to how to align any subsequent axes. The systems theory source paper (Adams, et al., 2014) aligns the 30 propositions to 7 axioms, so the researcher first looked at the data density against the 30 propositions. Table 10 represents the highest six nodes by cross connection after the three categories are excluded. This approach has a weakness in that it does not capture the strength of the relationship of these six nodes to the 3 categories of the first axis.

Table 9: Node Cross Connections Highlighting Top Three Cross-Connected Nodes

	A : Circular Ca	Communi	omplemen	: Contr	Darkness	namic Eq	Emerge	Equifina	Feedba	Hierarc	: Holis	omeosta	Homeostasis Re	Le	P : MCS	Multifina	: Pareto	OT-CAP	ositive E	Recurs	Redundan	V : RPC	laxation	uisite H	uisite P	equisite	Satisfic	elf Orga	ub-optim	ty	G : Viabil
1 : Circular Causality	[redacted]	3	2	7	3	1	5	2	20	3	3	0	1	1	10	2	1	0	4	0	2	1	2	0	0	0	0	1	0	5	0	14	0
2 : Communication	3	[redacted]	3	37	4	1	4	1	17	25	1	0	4	25	44	0	2	0	7	15	4	9	2	0	0	3	4	23	1	12	0	6	9
3 : Complementarity	2	3	[redacted]	12	3	0	6	1	1	4	20	0	2	1	13	3	0	0	8	3	0	0	0	0	0	0	0	8	0	5	2	3	1
4 : Control	7	37	12	[redacted]	12	8	16	5	46	48	9	2	17	5	40	2	1	0	17	28	5	5	8	7	0	0	0	24	0	13	5	21	9
5 : Darkness	3	4	3	12	93	0	5	1	10	3	12	0	0	0	22	3	2	0	4	1	0	0	1	0	1	0	0	8	0	1	0	15	0
6 : Dynamic Equilibrium	1	1	0	8	0	115	2	2	16	3	0	4	26	1	15	0	1	0	11	2	1	0	0	7	1	0	0	0	8	8	0	9	2
7 : Emergence	5	4	6	16	5	2	[redacted]	3	8	15	12	2	2	3	7	0	1	0	1	0	1	0	2	0	0	0	0	2	0	16	0	7	4
8 : Equifinality	2	1	1	5	1	2	3	88	4	3	1	1	2	0	25	1	13	0	27	4	1	1	0	0	0	0	0	3	5	3	2	19	0
9 : Feedback	20	17	1	46	10	16	6	4	[redacted]	10	2	2	25	6	28	1	1	0	15	9	5	3	0	4	0	0	0	8	0	5	0	36	4
10 : Hierarchy	3	25	4	49	3	3	15	3	10	[redacted]	7	3	8	10	27	1	2	0	6	13	9	6	5	1	3	1	0	8	1	14	4	14	11
11 : Holism	3	1	20	9	12	0	12	1	2	7	358	0	0	0	11	1	0	0	0	8	2	0	0	0	0	2	0	0	0	3	1	1	2
12 : Homeorhesis	0	0	0	2	0	4	2	1	2	3	0	34	16	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	2	0	0	0
13 : Homeostasis	1	4	2	17	0	28	2	2	25	8	0	15	318	0	2	2	0	0	1	9	2	1	0	2	0	0	0	5	0	6	0	5	1
14 : Information Redundanc	1	25	1	5	0	1	3	0	6	10	0	0	0	98	9	0	0	0	0	0	0	2	4	0	0					3	0	4	1
15 : Leadership	10	44	13	40	22	15	7	25	28	27	11	0	2	9	[redacted]	19	6	0	[redacted]	46	11	2	1								35	[redacted]	18
16 : MCS	2	0	3	2	3	0	0	1	1	1	1	0	2	0	19	57	0	1	10	0	0	1									0	3	0
17 : Multifinality	1	2	0	1	2	1	1	13	1	2	0	1	0	0	6	0	55	0	8	15	0	0									0	6	0
18 : Pareto	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	77	2	0	0	0									0	2	0
19 : POT-CAP-ACT	4	7	8	17	4	11	1	27	15	6	0	0	1	0	[redacted]	10	8	2	[redacted]	22	2	2									41	71	4
20 : Purposive Behavior	0	15	3	28	1	2	0	4	9	13	8	1	9	0	46	0	15	0	22	[redacted]	3	0									0	13	5
21 : Recursion	2	4	0	5	0	1	1	1	5	9	2	1	2	0	11	0	0	0	2	3	106	1									8	15	12
22 : Redundancy	1	9	0	5	0	0	0	1	3	6	0	0	1	2	2	1	0	0	2	0	1	71									5	6	1
23 : RPC	2	2	0	8	1	0	2	0	0	5	0	0	0	4	1	0	0	0	0	0	0	2									1	1	1
24 : Relaxation Time	0	0	0	7	0	7	0	0	4	1	0	1	2	0	27	0	0	0	14	0	1	0	0	0	0	0	0	0	0	0	0	30	0
25 : Requisite Hierarchy	0	0	0	0	1	1	0	0	0	3	0	0	0	0	10	2	0	0	9	2	2	0	0	0	48	0	0	4	0	2	0	4	1
26 : Requisite Parsimony	0	3	0	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	38	14	0	1	1	0	0	0
27 : Requisite Saliency	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	2	11	0	0	0	0	0	14	70	0	0	0	0	1	0
28 : Requisite Variety	1	23	8	24	8	0	2	3	8	8	0	0	5	2	30	5	2	0	14	2	4	4	1	0	4	0	0	[redacted]	0	10	0	15	7
29 : Satisficing	0	1	0	0	0	8	0	5	0	1	0	0	0	0	41	0	0	0	24	0	0	0	0	0	0	1	0	0	98	0	2	19	4
30 : Self Organizing	5	12	5	13	1	8	16	3	5	14	3	2	6	3	28	6	2	0	10	8	8	5	1	0	2	1	0	10	0	[redacted]	0	18	12
31 : Sub-optimization	0	0	2	5	0	0	0	2	0	4	1	0	0	0	35	0	0	0	41	0	0	1	0	0	0	0	0	0	2	0	93	1	1
32 : Temporal relationship	14	6	3	21	15	9	7	19	36	14	1	0	5	4	130	3	6	2	71	13	16	6	1	39	4	3	1	15	19	18	1	[redacted]	6
33 : Viability	0	9	1	9	0	2	4	0	4	11	2	0	1	1	18	0	0	0	4	5	12	1	1	0	1	0	0	7	4	12	1	6	110

Three most cross connected node pairs

Table 10: Second Tier Nodes by Cross-Connection Strength



To correct the weakness noted above and to capture the relationship of the 3 categories with the remaining 30 nodes, the researcher returned to Nvivo Version 10 (Richards, 2013) and developed a different node matrix. This node matrix was the cross-relationship between only the first three categories and each of the remaining 30 nodes. This was further constrained by filtering each column for the top cross connections. The filter was selected and then varied to limit the number of nodes to within Miller's magic number 7 plus or minus 2 (G. Miller, 1956). Table 11 represents the relationship between the highest cross referenced 3 nodes (personal capability categories) and the remaining 30 nodes filtered to ensure that all remaining nodes cross-connect with all three personal capability categories.

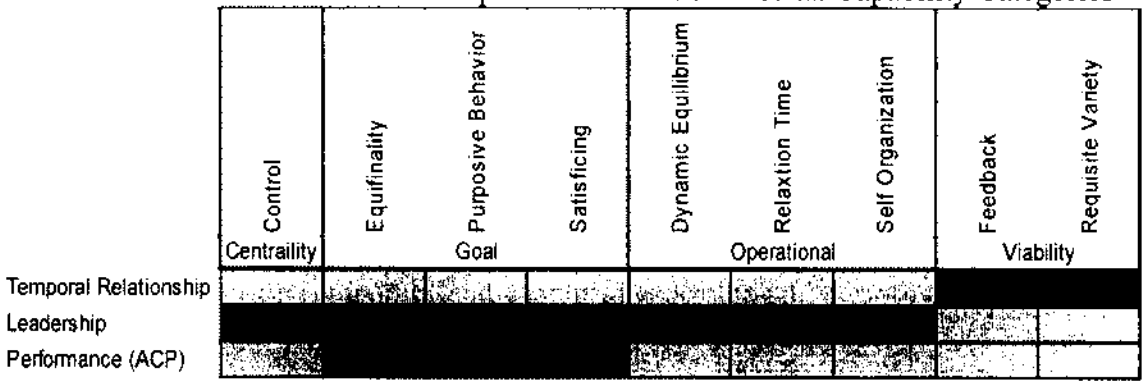
Table 11: Cross-Connection between 3 Personal Capability Nodes and 30 Systems Theory Nodes.

	Temporal relationship	Leadership	Performance (ACP)
4 : Control			17
6 : Dynamic Equilibrium	9	15	11
8 : Equifinality			
9 : Feedback			15
18 : Purposive Behavior	13		
22 : Relaxation Time			14
26 : Requisite Variety	15		14
27 : Satisficing			
28 : Self Organizing	18		10

The next step was to sort the 9 selected systems theory nodes by axiom. The 9 nodes displayed in Table 11 represent only 4 of the 7 axioms from Adams (2014),

creating a representation of the framework organized by Proposition and Axiom versus the three categories of Temporal Relationships, Leadership and Performance as shown in Table 12.

Table 12: Axioms and Propositions versus 3 Personal Capability Categories



This analysis allowed the researcher to begin the detailed construction of the framework using the data elements pertaining to the nodes identified in Table 12: Axioms and Propositions versus 3 Personal Capability Categories.

4.5 SELECTIVE CODING AND CONSTRUCTING THE INITIAL FRAMEWORK

In selective coding, the researcher is "integrating and refining the theory (Strauss & Corbin, 1998, p. 143)." The researcher's challenge is to develop an interrelated set of concepts, not merely a listing of themes (Strauss & Corbin, 1998). This was truly a challenging step, as the researcher attempted to sort through the data elements manually, producing several lists, yet recognizing that they were not interrelated. Then, the researcher realized that the Nvivo software package could assemble the cross-linked data

and interrelate the data in matrices as noted earlier. The matrix structure was then used to reduce the numerous data elements in those cells to a cogent expression of the interrelated ideas captured at the axis levels. As noted by Glaser and Strauss, once it becomes right, the answer is almost obvious, almost a crystallization of the framework (Glaser & Strauss, 1967).

The previous sections contain an outline of how the framework was initially developed based on reduction of the 4981 data elements to a 3X4 matrix. One of the fundamental assumptions is that frequency of cross-connection in the coding is related to importance. This assumption is based on the analysis that the literature data elements are themselves a reflection of a large number of authors working to advance their science on the topical problems that have presented themselves to those authors. This section uses the data elements to build meaning for each of the pieces of the framework. The 3X4 matrix is expanded a 3X9 matrix to capture more depth in the definitions of the matrix elements. The expansion is performed by selecting propositions under the highest cross-correlated axioms. The next step is to re-examine the individual definition of each of the elements along the axes of the framework. This is performed by reviewing the seminal document for the propositions developed by (Adams, et al., 2014), and any modifications or expansions resulting from the literature data search, and the codebook pages developed by the researcher and used for the literature data search and coding. The definitions are contained in Table 13.

Table 13: Framework Axis Elements

Proposition or Personal Capability	Description
Control	Control was initially defined as "the process by means of which a whole entity retains its identity and/or performance under changing circumstances." (Checkland, 1993, pp. 313-314) Additionally, control will include the following additional perspective "Management control systems provide information that is intended to be useful to managers in performing their jobs and to assist organizations in developing and maintaining viable patterns of behaviour."(Otley, 1999, p. 364)
Equifinality	"If a steady state is reached in an open system, it is independent of the initial conditions, and determined only by the system parameters, i.e. rates of reaction and transport." (Adams, et al., 2014, p. 9)
Purposive Behavior	"Purposeful behavior is meant to denote that the act or behavior may be interpreted as directed to the attainment of a goal-i.e., to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event." (Adams, et al., 2014, p. 10)
Satisficing	The decision making process whereby one chooses an option that is, while perhaps not the best, good enough.(Adams, et al., 2014, p. 10)
Dynamic Equilibrium	For a system to be in a state of equilibrium, all subsystems must be in equilibrium. All subsystems being in a state of equilibrium, the system must be in equilibrium.(Adams, et al., 2014, p. 9) The definition is expanded to include Bertalanffy's conception of an open system that is equilibrium through the exchange of matter and energy. (Bertalanffy, 1950b)
Relaxation Time	Stability near an equilibrium state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property. The system's equilibrium state is shorter than the mean time between disturbances.(Adams, et al., 2014, p. 10)
Self-Organizing	The spontaneous emergence of order out of the local interactions between initially independent components.(Adams, et al., 2014, p. 10)
Feedback	All purposeful behavior may be considered to require negative feed-back. If a goal is to be attained, some signals from the goal are necessary at some time to direct the behavior. (Adams, et al., 2014, p. 9)
Requisite Variety	Control can be obtained only if the variety of the controller is at least as great as the variety of the situation to be controlled. (Adams, et al., 2014, p. 10)

Table 13: Framework Axis Elements (Cont)

Proposition or Personal Capability	Description
Performance	Performance is a very value laden term, hard to define. However, Beer provided insights when he developed his concepts of Actuality, Capability and Potentiality (Beer, 1979). However, before we get to Beer, we diverge through Lebas and a definition derived from his work Performance is about deploying and managing well the components of the production factors that lead to the time attainment of stated objectives within constraints specific to the activity and support organizations within the boundaries... of the situation (Lebas, 1995, p. 29). Once we understand this definition, we can apply Beer's methods of developing 3 related indices to measure that performance. As Beer explained in a 1994 speech, one can construct three indices of performance: The answer is to reduce every input datum to a triple index in which all numbers range simply between 0 and 1. When the operational research teams touring the plants had made their models and identified the critical variables, they were asked to agree two values relating to each variable with the management. The first value was capability. This means: how should this variable perform under existing conditions, when the whole system is running in the smoothest way we have every experienced or; can envisage? So capability is not same thing as traditional since many processes work below their 'theoretical limits - because they are embedded in a productive system. Capability takes account of the Systematic reality using the quantified flow chart to understand it. The second value to be agreed for each critical, variable was potentiality. This stands for a better performance than capability, based on the realization that if only we had a better lubricant, or if could install a conveyor belt, and so on, then we could do this much better. It is evident that the values for capability and potentiality will not change frequently. They can be stored in the computer, and their ratio provides an index called latency: the latent performance that that could be released by new investment. The datum arriving dally over cybernet is called actuality. The ratio between this actuality and the capability yields the classic index of productivity, while the ratio between actuality and potentiality yields the overall performance index. Performance can also be computed by multiplying together the indices for latency and productivity.(Beer, 1994, pp. 7-8) In summary, relying on Beer, actuality is the performance seen today, capability is the performance that could be seen by the current system operating at its best, and potentiality is what the system could achieve by restructuring or addition of resources.

Table 13: Framework Axis Elements (Cont)

Proposition or Personal Capability	Description
Temporal Relationship	Temporal Relationship captures the effects of organization actions over time. This category emerged from the open coding of the literature data set. There are two perspectives depending on the direction the observer is looking. The first, which I call Past-Now-Future, is the resulting picture formed by first looking at the organization's past through the lens of today and predicting or estimating what the future will look like based on that past, constrained by the present. Exogenous factors may or may not be included in the determination of the future. The second perspective is called Future-Now-Past. The key difference is that a future picture is created of where the organization wants to be, then that future is compared to the present to identify the changes and resources required to get to that future, and the lessons of the past are included to determine if different actions or paths must be followed. Again, exogenous changes may be included in the depiction of the desired future. The two futures (P-N-F and F-N-P) are likely to be different, and those differences would drive actions in and of themselves, if they are examined.
Leadership	Leadership, like Performance is a value laden term. Leadership, like Temporal Relationships, emerged from the open coding. Numerous definitions exist; none satisfy everyone, or even a majority of people. The researcher chose to use a two part definition to constrain the meaning to the Systems Theory literature data set, rather than conducting a wholly separate data search of the management and leadership body of knowledge The first part comes from Drucker, "Management is doing things right, leadership is doing the right things." (Covey & Nathan, 2011, p. 108) The second part of the definition comes from the idea that leadership is what causes people to successfully work together to reach an enormously difficult goal that would not have been achieved without that leadership being present.

4.6 THEMATIC DEVELOPMENT OF THE COMPETENCY MODEL FRAMEWORK

The next step is to further winnow the multitude of data elements to a selection that serves to define the intersection of the horizontal and vertical categories. The following section includes the selected elements, as well as their source document. As the framework is developing, some of the elements are exact quotes, while others are rephrased to capture the concepts more clearly in the respective category. This selection retains the language of Systems theory, but is preparatory for developing an outcomes based competency model framework. A sample of the framework elements are presented here. The full selection of the components in the framework at this stage is in Appendix B.

Intersection of Control and Temporal Relationships

Time lags are most restrictive at low frequencies (Chandler, Herman, & Montroll, 1958).

Able to change goals (Achterbergh & Vriens, 2002).

Understand patterns over time (Morrison, Goldsmith, & Siegel, 2008).

Prediction => Control => rewards (K. A. Richardson & Tait, 2010).

Observer cannot see system and what system sees (Marken, 1990) .

Elements at one location have significant time-space effects elsewhere through multiple connections and trajectories (Urry, 2005, p. 238).

All self-organizing systems become informed of their world or perish (Scott, 2004, p. 1367).

The language used is from the systems theory and not oriented to any particular typology. As discussed earlier, this version of the framework will be translated to an outcome based competency model framework during the Superinduction of the theory. This will be presented in the next section.

4.7 DISCOVERER'S INDUCTION APPLIED TO THE DRAFT FRAMEWORK

This crucial step involved taking the draft framework, in systems theory terms, and applying an outcome based typological terminology upon the content of each cell in the framework. The very early literature search in the competency literature had provided the researcher insight into the structure of an outcomes based competency model (T. Hoffmann, 1999). This insight assisted in the superinduction needed to create the systems theory based competency model framework. The result is the current framework that is reported in Chapter 5. The researcher used Whewell's *determination of the magnitudes* to create the scale for assessment of competency models (Whewell, 1858). This is discussed in the next section.

4.8 DETERMINATION OF THE MAGNITUDES

Whewell (1858, p. 187) used a term called *determination of the magnitudes* to describe that portion of theory building where coefficients for terms in the theory are established. In the qualitative theory that is being built here, those terms would be a Likert scale for assessing an organization's competency model's compliance to the competency model framework. The researcher used a Likert scale previously established for prior research. The grading follows a scale developed by a working group in an unpublished report in the summer of 2011. The grades are: Unacceptable (UN),

Adequate (AD), VG (very Good) and Excellent (EX). Descriptions of the grades are as follows:

- Unacceptable: Not present, or so poorly described as to be unexecutable by the most skilled individuals;

- Adequate: Meets minimum standards, is clear enough to be executed, but has gaps or missing elements;

- Very Good: Is well above standards, with sufficient detail to guide the person tasked to execute, with one or few missing elements;

- Excellent: Is the highest standard, with clear details meeting all the requirements of Minimum Critical Specification, and no missing elements.

This scale is applied to the Competency Model Framework assessment presented in Appendix D and E.

4.9 TRIANGULATION OF THE COMPETENCY MODEL FRAMEWORK

Following selective coding and thematic development, a nascent framework was now in existence. However, the researcher was concerned that some major concept might have been left outside the matrix by the winnowing process. Only 9 of 30 propositions were directly represented and a lingering question arose - is there a big idea lurking in the remaining literature data pool? To answer that question, a different view of the data was undertaken. Recognizing that the framework contained a population of concepts, Nvivo was used to perform a Word Query for the top 100 terms. That list functioned as the baseline for the analysis. Using Nvivo, a node was created for each of the 7 axioms using

the corresponding propositions. Then, the exact same Word Query was executed for each of the axiom nodes providing a resulting list of 100 terms. Next, each of the 7 lists was compared to the earlier baseline list based on the competency model framework and identical or synonymous words were eliminated from the axiom Word Query results. This left between 40 and 65 terms for each axiom. Of those terms, the top three from each axiom were selected, leading to a list of 21 terms. However, several terms were duplicates and when duplicates were removed 17 unique terms remained. Finally, those terms were compared to the competency model framework to discover if any terms were missing from the competency model framework. 16 terms were immediately identifiable as present. The remaining term was not present, but its opposite was (i.e. *positive* was present, while *negative* was the query result term). The researcher concluded that the concept implied by the term was present, just that the antonym was dominant in the framework. A detailed pictorial describing this process in presented in Figure 24. The highly power law distribution of the search terms also allayed the researchers concern that more terms needed to be examined. The triangulation process validated that no major idea was left outside the draft framework.

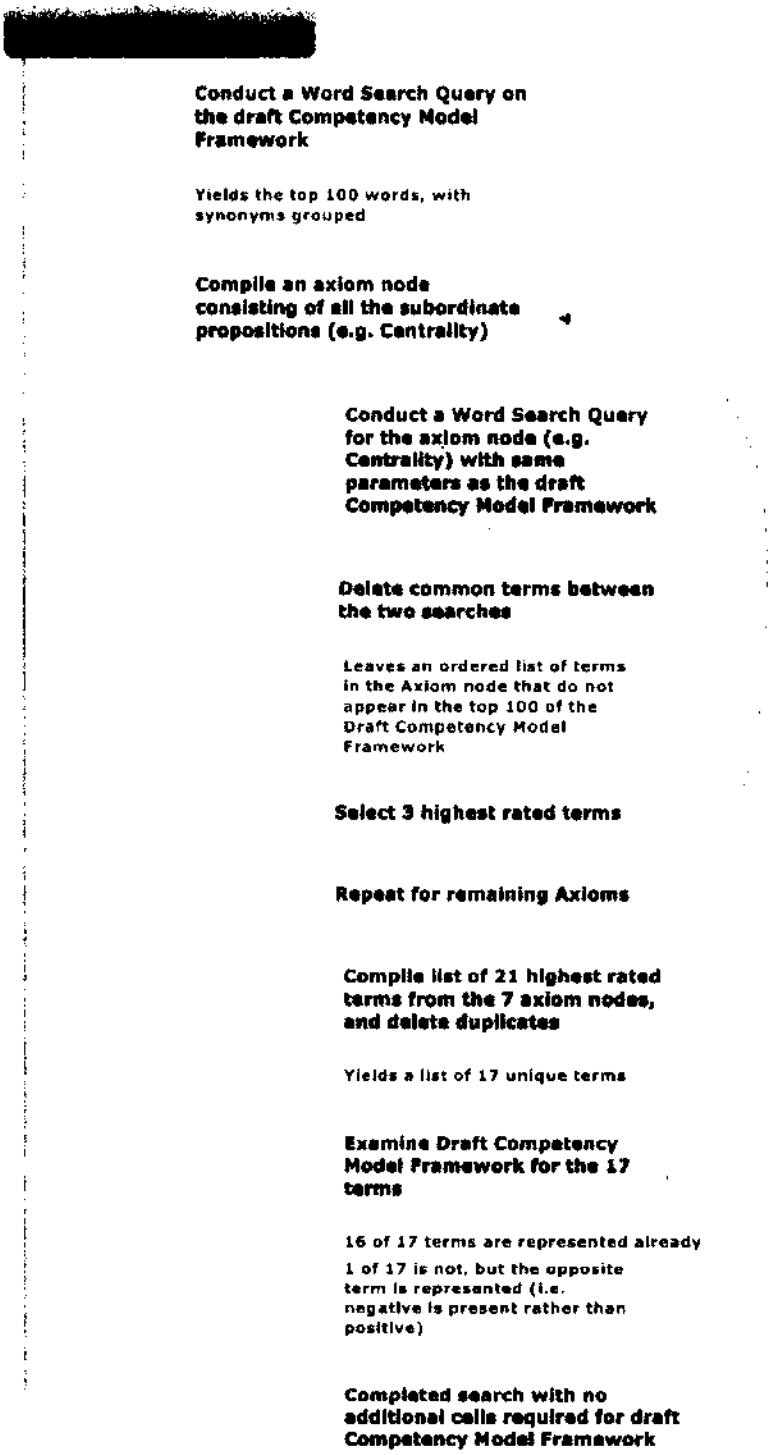


Figure 24 : Triangulation Process

This step represented the last phase of the inductive framework building portion of the research. The framework was constructed without any *a priori* conceptions of what it would look like by the structured application of grounded theory. Beginning with a literature data search, codebook construction and axial coding a massive data set was constructed from the systems theory literature. Axial coding was used to begin the construction of the framework by the collection of concepts into categories. By the selective coding phase was reached, one set of 3 categories stood out, those called the personal capability categories. These arose completely from the coding of the literature and had not been explicit search terms in the literature data search. As the thematic development phase took hold, the 9 highest correlated propositions were used to populate the second axis, and the data elements were translated to an outcome reference competency model framework. With the framework completed, the researcher transitioned to the case study portion of the research.

4.10 METHOD FOR CASE STUDY FACE VALIDATION OF FRAMEWORK

This case study seeks to answer the question: *What results from application of the systems theoretic competency model framework to analyze and extent competency model and operational setting?*

The first step of the case is development of the plan. Earlier, the researcher discussed the concepts of framework and typology. The framework that has been created has the contemporary temporal aspect noted by Yin (2009), and the relevant behaviors noted in the case study materials are not subject to manipulation. The case study serves as a face validation of the developing competency model framework and thus it is appropriate to use a case study for this phase (Eisenhardt, 1989).

The next step is the design of the case. This includes a determination of which extant competency model is used as the subject of the case, as well as, how it is framed against the new competency model framework. Site selection is an important consideration (Eisenhardt, 1989). The following factored into the consideration of possible sites:

- An actual competency model exists. Several potential participants were found to not have competency model in existence but were interested in the concept of the framework to build a new model. These sites were rejected.

- A governance structure exists. The presence of a governance structure intimates that the model may not only exist, but actually be used. At least one potential site reported having a competency model; however, the nominal administrator had not performed any competency model duties for the duration of his incumbency in the position (which was greater than five years). This site was rejected.

- An organization large enough to require a function to manage, maintain, improve the competency model. This requirement was designed to help ensure that competency model is curated.

- The competency model is tied to external requirements, either by law or code. This requirement was designed to improve the likelihood that the competency model reflected external, as well as internal factors, some of which might not be perceived to be needed internally.

- Organization needed to be willing to work with the researcher. This might seem obvious, but there are competency models available that would not have required any interaction between the researcher and the organization. This was viewed as less desirable due to the lack of potential for future research. While the research was limited to the documents provided, future research is likely with an organization which has contact with the researcher.

- Provision for anonymity. Many organizations prefer to participate in research anonymously. In this case, anonymity was a key element in obtaining support for the research.

The researcher sought out organizations that appeared to meet the requirements and established contacts at each. Short initial interviews verified potential organizations that met the requirements listed above. Several organizations expressed interest in follow-up, and subsequent discussions enabled reduction of the pool to one organization that met all of the above requirements.

This organization's competency models are required by law, have an active governance structure exists and the competency function is active. The organization has over 1000 employees, with a function dedicated to manage, maintain improve their competency models. Conveniently, the researcher contacted this organization just as leadership had internally decided that a review of their competency models was in order and the potential for a new approach was very attractive. Especially exciting to this organization was the researcher's offer to report on gaps in their extant model that would be identified by the new competency model framework.

The design continued with a discussion of the organization's competency models. Due to the scope of the research, only a portion of the existing competency models was selected for the case study – the portion that focuses on leadership. The organization provided the most recent version of their competency model just as the competency model framework was completed.

As noted in the discussion of *determination of the magnitudes*, a scale was designed for each cell of the competency model framework. The scale ranges from unacceptable to excellent with two intermediate positions of adequate and very good, with descriptions of each level. The case study propositions examined each element of the competency model framework and searched for its analog in the organization's competency model. The researcher made and recorded a concurrent assessment of the organization's standing against the scale noted above. This links the data to the propositions and includes the criteria for interpreting findings (Yin, 2009). The results of the case study are tabulated in Appendix E and discussed in the next chapter.

4.11 SUMMARY

In this chapter, the research design and detailed procedures for both the grounded theory development of the competency model framework and the face validation case study were presented. As expected, the grounded theory portion of this research proceeded in a highly non-linear, iterative manner rather than the nicely linear depiction of flat drawings. Beginning with a literature data search, development of the codebook and open coding of the literature data set, the data elements were disassembled pieces, but ready to be re-assembled. Axial coding began the re-assembly process with the focus on identification of the most highly cross-correlated nodes. Early identification of the

personal capability categories provided the first potential axis of the framework. The selective coding and thematic development clarified the second axis of the framework as well created the framework elements in their final form. Triangulation was performed by re-examining all the axioms for missing elements from the framework, with the result that 21 most highly rated terms were located within the framework, either directly or by the apposite term. The iterations allowed exploration of multiple, disparate data elements that coalesced into a comprehensive, tight framework. The details of the framework will be presented in Chapter 5.

In the face validation case study, the new competency model framework was applied against an existing competency model. This model has been in use for a number of years, is required by law and has an active governance function. The participating organization noted problems similar to the literature and was receptive to an external examination of their competency model through the lens of the new competency model framework. The results of the case study will be provided in Chapter 5, following the explication of the new competency model framework.

5. FINDINGS

The previous chapter presented the research methods and detailed procedures for executing the creation of the competency model framework and the associated face validation case study. In this chapter, a discussion of middle range theory is followed by the completed competency model framework. While, the research is complete to this point, that is a transitory state and future research will be discussed in the following chapter. Following the presentation of the competency model framework, the face validation case study results are presented.

5.1 MIDDLE-RANGE THEORY PLACEMENT

This portion of the research set out to answer the question: *What framework can be developed for the analysis of competency models from a systems theory perspective?* The answer is a framework grounded in the literature that posits a middle-range theory. The research chronicled in previous chapters served to develop a middle-rage theory. "Middle range theories focus on delimited topics, make explicit efforts to combine concepts, and search for abstracted patterns and explanatory mechanisms (Geels, 2007, p. 626)." Middle-range theory was developed by Merton due to his concern that an all-encompassing system would be futile and sterile (1968), or in other words, a grand theory that is unusable, while a focus on data collection and data runs produces numerical results that few see themselves fitting, nor useful for the individual case (Geels, 2007). This middle range theory seeks to meet three criteria of *good theory* by trading between them. The three criteria are: (1) generality and scope, where this framework does not seek to encompass the world, nor it is mired in anecdotal cases; (2) simplicity, where this framework has reduced a huge body of knowledge to a limited number of clear, well

defined, grounded concepts; and (3) accuracy, where this framework can be traced directly back to the source documents via the discipline of the grounded theory coding. This framework has met the challenge of meeting the three criteria discussed above and is well placed in the middle range.

5.2 COMPETENCY MODEL FRAMEWORK

This section presents the competency model framework as a matrix. Recall that 516 sources were coded with 4981 data elements in the open coding phase. Axial coding identified three personal capability characteristics (temporal relationships, leadership and performance) that provided the first axis of the structure. The second axis arose from the propositions and axioms of systems theory. Nine systems theory propositions from within 4 axioms were identified as fundamental to the framework, with a triangulation exercise that confirmed no major terms had missed the framework. These concepts were refined and distilled through successive iterations in selective coding and framework construction. The resulting matrix captures the relationships between the personal capability characteristics and the proposition elements. Figure 25 depicts the evolution of the data to categories to concepts into a theory represented by a framework.

The entire or complete version of the framework is presented in Table 14: Competency Model Framework on the page following.

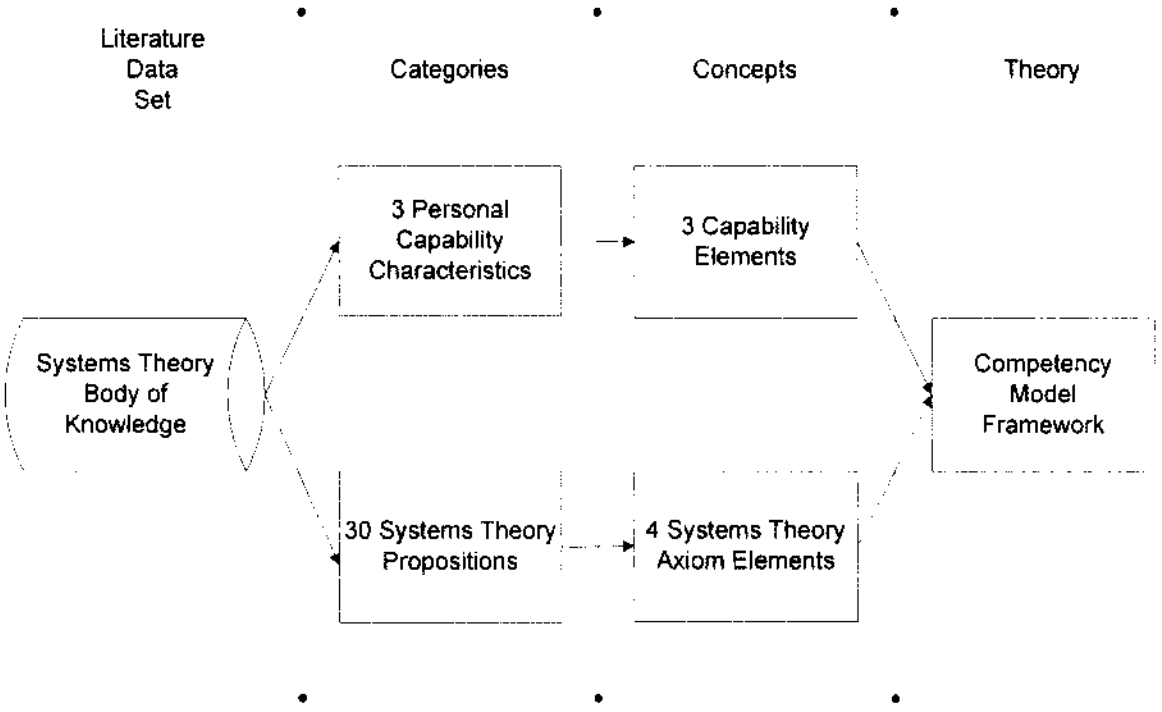


Figure 25: Competency Model Framework Development

The structure of the framework has the three capabilities in the vertical axis, while the axioms comprise the horizontal axis, with several of the axioms further divided by the supporting propositions. Each cell represents a competence that is the intersection of the capability and the axiom/proposition. Generally, one significant concept is contained in each cell. However, a number of cells contain more than one concept due to the incompressibility of the multiple concepts into a single concept without losing one (or both) components of the framework.

Table 14: Competency Model Framework

	Goal		
	Equifinality	**Purposive Behavior**	**Satisficing**
Temporal Relationship	Understands the hidden and delayed system responses that only become visible through time. Uses understanding of time in selecting which of many pathways is more likely to result in reaching the desired organizational goals.	Purposefully combines principles of time, consciousness, boundaries and goals to logically connect them into actions that, over time, allow or enable the organization to meet its goals.	Recognizes time is the only scarce resource. Builds or uses satisficing processes, when appropriate, to manage changing needs and interests. Makes timely responses to ill structured, dynamic environments or conflicting goals rather than searching for an optimal solution.
Leadership	Understands and uses the opportunities presented by multiple paths to the same end state for organizational advantage, while recognizing the small changes that can result in dramatically different outcomes. Capable of recognizing these small changes in modifying the organization and its actions to prevent being undone by those seemingly small factors.	Able to communicate concerning communicatively constructed knowledge to impact primary processes and goals, gaps, causes, and actions. Uses leadership skills to control internal definitions and map the problematique before moving to design alternatives.	Uses satisficing to achieve degrees of fulfillment rather than striving for absolute success or failure. Facilitates the organization to do things that they could not otherwise do, and recognizes that connections may be direct, but just as likely to be indirect, but that precision will allow identification of the required requisite variety.
Performance [A-C-P]	Understands how ambiguity will drive many managers to pick a single idea, a single function, or a single solution to the detriment of the organization. Is able to deal with that ambiguity both on a personal and organization level to prevent being limited by the choice of one.	Using skills in formal operations, selects or guides the proper starting point for investigation. Uses knowledge of mental models to overcome flaws including: 1) not incorporating individual into the organization; 2) not representing the hierarchy of control; 3) relying on espoused theories vice recognizing theories in use.	Understands that optimized organizations are inflexible, whereas satisficing enables dynamic boundaries and loose coupling. Knows how to decide and does so well.

Table 14: Competency Model Framework (Cont.)

	Operational		
	Dynamic Equilibrium	**Relaxation Time**	**Self-Organization**
[redacted]	Rather than using approaches that define the processes as successive macroscopic equilibrium states which do not depend on time, is able to deal directly with disorder, instability, nonlinear relationships between open systems, evolution and temporal relationships. Uses approaches that include disequilibrium, amplifying action, recombination and stabilizing feedback as part of the necessary suite of processes for newly emergent order.	Understands system responses to shocks, how to consider relaxation time when implementing change and does not ignore relaxation time when considering complicated trade-offs in resource utilization. Understands and uses differences in relaxation times between systems to the advantage of the organization.	Understands the value of proximity to drive interaction within the commonly found nested hierarchical structures. Uses this understanding to drive interactions on multiple timescales, in parallel and series, synchronous or asynchronously with the goal of establishing the requisite variety for the organization to achieve its goals.
Leadership	Recognizes and takes advantage of crossovers, despite their speed of occurrence, and coordinates the organization getting to a new (and better) basin of stability. Resists the tendency to use averages when specifics are needed to predict future performance.	Knows how to respond to newness and adopt organization to new assemblies in the face of instability, despite the inherent difficulty of determining relaxation time in a complex system with multiple exogenous sources of change. Able to respond differently over time as the organization changes and is changed.	Designs the organization to reduce deficiencies that impair viability, includes redundancy to provide adaptability, all with the minimum specifications to allow the freedom to find the needed paths to organizational goals. Recognizes that leadership is affected by followers rather than existing in isolation.
[redacted]	Designs the system for continual self modification in the face of instability by holistically managing the constituent systems and using dynamic models.	Understands that transients impose costs on the organization. Understands the transients will have different effects at different scales, and different responses at different scales, and is able use the differences to the organization's benefit (or reduce/mitigate).	Understands social capital must not be undermined by crippling policies, but enabled by the creation and fostering of effective spaces for adaptive cooperation. These spaces must exist recursively at all levels in the organization and allow unpredictable emergent behaviors that give rise to courses of action that are different than expected.

Table 14: Competency Model Framework (Cont.)

	Viability		Centrality
	Feedback	**Requisite Variety**	**Control**
[redacted]	Uses feedback lens to enrich the understanding of the situation, while also recognizing that feedback can help or hinder by setting boundaries. Self-defeating feedback loops identified and mitigated by improving meaning making.	Understands how requisite variety enables a system to continuously develop as the environment also develops. Able to take advantage of or use the information explosion that results from continuous development.	Understands patterns as well as the world around the organization and the impact of those patterns on the organization. Has a deep understanding of the organization and its environment that enables the use of time and control functions to predict performance, use system understanding to create, and revise goals to improve organization performance.
Leadership	Able to use feedback, especially nonlinear feedback, to support emergence, self organization, adaptation and learning. When placed within an integrated performance measurement system, the corporate strategy is linked to the objectives, and individual goals are aligned to this context with regular feedback on progress, with needs for improving the performance linked to rewards based on results.	Understands requisite variety allows and takes advantage of unexpected use of the system, unexpected behaviors, and responding to previously unknown problems to solve. Fosters socio-technical perspective rather than a one-man/one job perspective to enable necessary roles to be filled.	Has the ability to set organization goals, translate the organizational goals to function goals, and constructs to enable hierarchical levels to meet their goals nearly simultaneously. Establishes these goals so as to reduce internal conflicts while dealing with ambiguity and change in the organization and its environment.
[redacted]	Develops both autopoieitic and executive controls to set targets and monitor performance and causes action to close gaps between performance and goals. Uses, improves, expands workforce knowledge to achieve desired organization results.	Enables meaning making to get more strategic thinking, higher levels of collaboration, beneficial feedback, better conflict resolution, better subordinate development. Redefines challenges to get higher performance with designs evolved in response to feedback.	Able to discern the boundary or limit to performance with current system and only expends the resources needed to approach that limit. Seeks out different tools/ideas/skills to jump system to a higher region with expanded limits.

The framework was constructed from 516 scholarly works that were decomposed into 4981 empirical facts. The 4981 facts were coded into 33 concepts. The 33 concepts were grouped into 3 personal capabilities categories and 9 propositional categories. The intersection of the 3 personal capability categories and 9 propositional categories created a 27 element framework. The 27 element framework used an ordinal scale to evaluate the measurement criteria. Once the framework was developed, reviewed and the researcher had reached saturation with the state of the framework, the research proceeded to the case study phase. This will be discussed in the next section.

5.3 CASE STUDY RESULTS

Recalling that the case study seeks to answer the question: *what results from application of the systems theoretic competency model framework to analyze and extent competency model and operational setting?* As discussed in Chapter 4, the active competency model for one large defense related organization was subjected to the newly created competency model framework using the checklist of Appendix E. The detailed results are contained in Appendix E with scores and comments by the researcher discussing the components of the competency model that drove each score. A summary table representing the scores and the associated organization competency model elements supporting that score is presented in Table 15.

Table 15: Case Study Grading Results from Competency Model Framework

Axiom		Goal			Operational			Viability		Centrality
Proposition		Equifinality	Purposive Behavior	Satisficing	Dynamic Equilibrium	Relaxation Time	Self Organizing	Feedback	Requisite Variety	Control
	Temporal Relationship	[illegible]	EX (C1)	**VG (C1)**	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	EX (C4, C5, B10)
	Leadership	[illegible]	EX (A1,C4)	[illegible]	**VG (C2,C3)**	EX (B3,B10, C3)	**VG (B1, B7)**	[illegible]	**VG (B7)**	**VG (C5)**
	Performance	EX (B8)	EX (B3, B8)	**VG (A2,B4)**	EX (A1,B4)	[illegible]	**VG (B2, B3)**	[illegible]	[illegible]	**VG (C5)**

Each table cell contains the grade for the cell and the reference cells from the organization's competency model that contribute to the grade. The grades are:
- Unacceptable: Not present, or so poorly described as to be unexecutable by the most skilled individuals;
- Adequate: Meets minimum standards, is clear enough to be executed, but has gaps or missing elements;
- Very Good: Is well above standards, with sufficient detail to guide the person tasked to execute, with one or few missing elements;
- Excellent: Is the highest standard, with clear details meeting all the requirements of a Minimum Critical Specification, and has no missing elements.

The application of the competency model framework against the extant competency model showed several gaps, with many sections having incomplete coverage. The relatively small number of gaps was somewhat surprising, while the predominance of partial coverage was expected. Only 7 of 27 framework elements were assessed as Excellent coverage, and it should be noted that Excellent coverage did not imply 100% coverage. Each of the major themes had a relatively flat distribution. No theme had a truly dominant score. Two of the unsatisfactory grades fell in the same proposition – Relaxation Time. The proposition was covered from the leadership perspective by connecting the concept across three cells of the organization's competency model, yet the term was not used (nor expected to be used). Many of the terms from systems theory are not used and the idea of Troncale's discynims had to be broadly applied in many instances. A summary of the scores is presented in Table 16

Table 16: Summary of Framework Scores

	Grading Selection			
	UN	AD	VG	EX
Section: Temporal Relationship	2	4	1	2
Section: Leadership	0	3	4	2
Section: Performance	1	2	3	3
Summary	3	9	8	7

The researcher's sense is that this competency model reflects a fair number of systems theory propositions, but could be made much stronger by the application of the competency model framework in a transformation effort.

The case study was conducted to answer the research question "What results from the application of the systems theoretic competency model framework to analyze a

competency model in an operational setting." The case study successfully provides an answer that contains several elements: 1) the framework provides a systems theory based method to assess competency models, 2) actual gaps in the extant competency model were identified, and 3) recommendations were made to the participating organization on improvements that could be made to their competency model. The completion of the case study allows transition to the end of this research, with a discussion of future research in the next chapter.

5.4 SUMMARY

In this chapter the completed competency model framework was presented, in its complete format as a middle-range theory. This means is does not seek to answer all competency model questions, but some important ones nonetheless. The framework is the intersection of 3 capability elements with 9 systems theory proposition elements. This provides a robust framework for the development, assessment and transformation of competency models. This inductively created systems theory based competency model framework answers the first research question and meets the associated objective.

In the face validation case study, the researcher presented the results of running an extant competency model through the competency model framework. Gaps were identified that can be used to drive a transformation effort by the owning organization. Further, the presence, to some degree, of the remaining 24 elements indicates that the organization's existing competency model is not overly lacking from a systems theory perspective. The case study answers the second research question and meets the associated objective.

The combination of completed competency model framework and associated case study meet the purpose established at the beginning of the research effort. Additionally, the use of Whewell's Discoverer's Induction complemented by Grounded theory has invoked a new approach to researchers with similar research purposes.

6. IMPLICATIONS AND FUTURE RESEARCH

In the previous chapter, the findings for the Competency Model Framework and the Case study were presented. The researcher now shifts to the implications, both broad and narrow that can be drawn from the research. The research also generated numerous ideas for further study. Some were developed by the researcher, a number were developed by reviewers and peers discussing the progress of the research. All are fascinating and provide a cogent direction for further research in response to the research findings.

6.1 IMPLICATIONS OF THE RESEARCH

Returning to the original premise of this research, an examination of the Purpose, Objectives and Questions frames the implications. Figure 26 refreshes our memory of that starting point. Based on the review of the competency literature, a completely new method of generating competency models was called for, as well as application to the real world. This purpose has been satisfied by the research.

Two objectives were identified and met. The previous chapter contains the fully developed competency model framework inductively developed from the systems theory literature. Further, the case study applied the framework to an extant competency model that met a number of strict requirements for consideration.

Thus both research questions are answered. A robust systems-based, yet easy to apply competency model framework has been produced. The framework contains a depth of detail that ensures the user who seeks to develop, assess or transform a competency model that it is robust and sufficient for those purposes. The case study provided face

validation that framework can identify gaps, as well as indicate where a model is already complete.

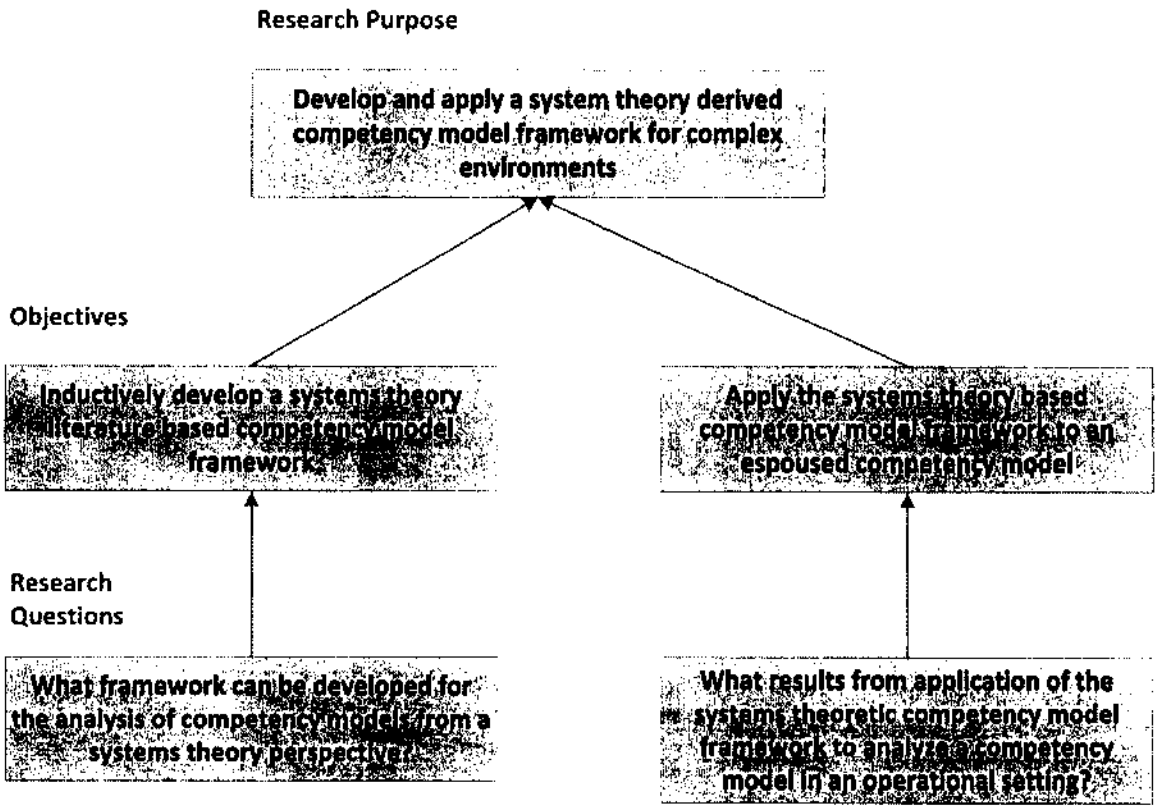


Figure 26: Research Purpose, Objectives and Questions

6.1.1 CONTRIBUTION TO THE THEORY

The first contribution is the startling realization that the researcher actually developed a creative new method for the construction of competency models. When starting out on this research, the literature provided insights into the methods that already dominate the field, exemplar-fully successful comparison, or Delphi survey techniques, and no insight into how to create a third method. Through the step by step development of this research, a third method has indeed been *discovered by induction* as Whewell

proposed. The connection to grounded theory provided the detailed approach to handling the volume of data.

6.1.2 CONTRIBUTION TO THE PRACTICE

As result of this research, practitioners in the field have a method to design, assess and transform competency models based on systems theory. Using Appendix D, a practitioner can sit down with an existing competency model and in a relatively short period of time, come away with an assessment of that model, a list of gaps and an assessment of what is already sufficient. Where there is no competency model, the practitioner has an alternative approach to designing a new competency model. Where the organization is unhappy with results, and assesses their models as part of the problem, this method gives guidance on where transformation is required.

6.1.3 CONTRIBUTION TO METHOD

The combination of Whewell's Discoverer's Induction and grounded theory is relatively rare. The researcher was unable to locate any journal papers after an exhaustive search of multiple databases that chronicle this combination of Whewell's Discoverer's Induction and grounded theory. The integration was essential, in this researcher's view, to accomplishing the research. It also appears to be a powerful combination for tackling other large scale problems, especially, where the problem requires examination of the field's underlying assumptions with an accompanying large volume of literature. Rothwell and Lindholm (1999) made clear the perceived need to approach competency models from a different perspective, that drove the development of a new method that could be used in similar situations.

6.2 FUTURE RESEARCH DIRECTIONS

As noted above, this research generated many ideas. The concept of having a continuously evolving listing of future studies served a number of roles. The first was as an assistant in scope control. Whenever an idea surfaced that looked interesting, but was not directly contributing to the two research questions, the idea went on the future research list. The second role was helping to lay out a possible future. When one completes a doctoral program, a natural question is *What is next?* The future research list is helping to answer that question. Combined, the two purposes served to limit the scope of the current research while offering the promise of coming back to the idea after the dissertation was complete. There are three general groups of opportunities in the following sections. The first group is ideas that follow directly from the research effort. and could be considered *next steps*. The second group is ideas that represent a parallel or similar concept to the research, but were not explored since they were not part of the core concept. The third group consists of areas of research that were encountered but are in entirely different domains or might be thought of as *far afield*. The literature in these areas were encountered as part of the literature data search, but were so far afield they had to be put aside for later efforts and potential application to the competency model framework

This research included a case study which is focused on *espoused theory*. An immediately interesting idea is how the *espoused theory* compares to *theory-in-use*. A particularly fruitful study would compare the espoused theory as captured by the case study with the actual performance of the competency model actions by the organization that provided a sample case study material. This research would help illustrate any

additional gaps between the theoretical framework and the actual competency model used by the industrial organization. Further, the site that provided the case study materials is only one of several similar organizations. The research could be expanded to all the sites and examine how different cultures have different theories-in-use and which if any factors have impact on the competency models and how they are used.

A second potential topic generated by this research concerns using Delphi methods to compare the views of the framework by two different groups. The first group would be comprised of system thinkers, and the second group would be General Managers without distinction to their capability as system thinkers. This research would depend on using a new tool, developed by a fellow researcher, to identify the system thinkers using the new scale.

Of particular interest to this researcher is the concept of action following some data gathering and decision-making processes. A significant question is how the organization's group that is responsible for the competency model modifies their model based on the information contained in the case study. A longitudinal study of the effects of those changes on both the model and the organization's performance would be particularly exciting. The loop could then be closed by examining any gaps in the framework competency model identified at the completion of the longitudinal study.

As noted above, parallel research developed a tool for measuring systems thinking on an individual basis. The combination of this tool in conjunction with the competency model framework seems to be a rich area to explore with the intent of improving system performance across time with enlightened leadership.

In the category of close or similar research, the following ideas were captured for future study. While this research was being conducted, the topic of Science, Technology, Engineering and Mathematics education (STEM) was never far from the discussions about competency. It would appear that the competency model framework could be of assistance in the STEM research being conducted today and worthy of future research.

This research was designed to allow the person or organization to analyze, design or transform a competency model, however, the details of how to actually perform those actions was not within the scope of this research. Certain ideas of how to accomplish those actions arose, sometimes from the literature, other times from creativity; however the specifics remained for future work. Further, the concept of how to measure those changes in organizational performance improvements (or degrades) also need to explore be explored.

A number of the propositions are, in the researchers estimate, in need of additional exploration. One example is *the principle of redundant potential command.* Questions arise such as: who does this well? What elements are required to be present to allow it to work well? What elements prevent it from occurring? How can it be repeatedly created? Literature on this topic is sparse, inviting one to pursue these questions further.

Two concepts from the *far afield* grouping are further study of critical systems heuristics and justified true beliefs. During the research, the field of critical systems heuristics, developed by Werner Ulrich, arose as data during the literature data search. A

deeper examination of this field seems likely to contribute to the understanding of organizations and how to improve their performance.

Another field developed during the literature data search is that of justified true beliefs (JTB). While peripheral to this research, the principles and methods of JTB seemed potentially helpful in developing a more complete systems theory.

6.3 SUMMARY

The researcher began this effort with the uneasy sense that there was a fundamental flaw in the way that competency models had been created as well as how the models were used. Rather than focusing on improving the existing and potentially flawed models, the researcher confirmed that others, more expert in the field, had also come to the conclusion that it was time to create competency models in a different manner. The competency model literature was surveyed for the existing methods and the flaws that have been identified in those methods. In parallel, the researcher was exposed to systems theory and recognized the potential for systems theory to be the foundation for a new theory of competency models.

The literature of inductive theory building was next explored to determine a valid approach for constructing the new theory. A combination of Discoverer's Induction and grounded theory was proposed to develop the theory. This combination was executed and a new competency model framework was developed. A rigorously selected case study was performed to examine an existing competency model through the lens of the new competency model framework. That lens found gaps in the existing competency model, weaknesses in certain areas and excellent coverage in a fraction of the existing

competency model. The case study validated the framework was useful in examining an extant competency model. Numerous areas of future research were identified during this effort.

Both research questions were answered in a manner that met the associated research objectives. The question: *What framework can be developed for the analysis of competency models from a systems theory perspective?* was answered by the development of an entirely new approach to competency model frameworks which can be used to design, assess, or transform a competency model. The approach actually developed a competency model framework with a systems theoretic perspective. The question: *What results from the application of the systems theoretic competency model framework to analyze a competency model in an operational setting?* was answered by the case study. The study revealed several (3) missing elements in the existing competency model, a large number (17) of weak areas and a fair number (7) of areas with excellent coverage from a systems theoretic perspective. Thus both objectives, (1) Inductively develop a systems theory literature based competency model framework, and (2) Apply the systems theory based competency model framework to an espoused competency model, were met. Meeting those objectives permits the researcher to assert the Research Purpose (Develop and apply a systems theory derived competency model framework for complex environments) has been met.

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APPENDIX A CODEBOOK

Using the guidelines provided by Saldaña (2013), a codebook was constructed to assist in clarifying the meaning of each code identified in the starting journal article. The codebook consisted of one codebook page per code with standard questions designed to frame the researcher's meaning of the code word. In most instances, the short definition provided by the authors was retained. In several instances, the definition was expanded. As the codebook page was developed, a search of online databases for the code word was conducted. This appendix captures the codebook after Expert Review comments were incorporated. Each codebook page is presented and is in three parts. The first part seeks to clarify the search term with respect to the seminal paper. Where needed, it prods for examples to help clarify the term. The second part seeks to further clarify the term as well as an initial placement in the competency model realm. A summary captures the thoughts of the researcher as the literature data search is conducted. The results of that search are captured as citations in the codebook page.

Axiom: Centrality Proposition: Communication	
Short Description	In communication, the amount of information is defined, in the simplest cases, to be measured by the logarithm of the number of available choices. Because most choices are binary, the unit of information is the bit, or binary digit.
Detailed Description	The theory is so general that it does not limit itself to any particular medium, it is so fundamental that it applies to all forms of communication,
Inclusion Criteria	Cryptography, language translation and chess playing algorithms are all discussed as flowing from Shannon's work.
Exclusion Criteria	If nothing flows (no signal) there is not a communication path
Typical Exemplars	See above
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	The communication of information is a prerequisite of the pair - communication and control.
How is it related to the proposition?	Communication is embedded in the definition of the axiom.
What features or principles are being drawn out?	Weaver and Shannon discuss three levels of the communication problem: Level A: how accurately can the symbols of communication be transmitted? Level B: How precisely do the transmitted symbols convey the precise meaning? Level C: How effectively does the received meaning affect conduct in the desired way? Weaver proposes that the three levels are so intertwined, they are inseparable
What specific details are being discussed?	The theory of communications at the very lowest level, in terms of binary digits (bits)
How does this translate to the competency framework?	The requirement to have successful communications would seem to be a fundamental requirement for competency. All three levels noted by Shannon and Weaver appear to apply.

Does a different axiom or proposition also get referenced?	Not directly - some discussions of the maximum rate and entropy appear to approach the Bohr concepts of complementarity, but they are not discussed directly.
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	The assumptions appear visible, and as the models are expanded to include noise and error checking, they become more visible.
What did I learn from this document?	Fascinating discussion of the theoretical underpinnings of modern communications theory. One can see extensions from the wiring/fiber/radio waves that Shannon was concerned with to spoken and written communications that Weaver discussed.
Why did I include this document?	Source reference
Was there a surprise?	No.
Did I see other areas to explore?	Further research on Shannon/Weaver in modern usage Lasswell's (1948) classic definition of communication is who (source or sender), says what (message), in which channel (medium), to who (audience or receiver), with what effect.(Danaher & Rossiter, 2011, p. 3) Whereas the Shannon-Weaver model of effective communication is about the message, McLuhan's (1964) insightful though extreme dictum that "the medium is the message" suggests that the correspondence recommendation should also apply to the medium or channel. (Danaher & Rossiter, 2011, p. 3)
Is a new code or codes required?	Communications, Feedback, Error-checking, noise

Summary: Communications –
Shannon is viewed as a seminal thinker in information theory. Indeed his two papers are highly cited and formed the foundation for much of the communications networks we have today. Shannon focused on the theory of the data, but not the content. His approach is highly mathematical, beginning with a simple model tracing the communication from source, encoding, transmission, decoding and delivery to the target. He develops the model to include the impact of noise, and mitigations to reduce the impact of that noise. His work on the theoretical limits of accuracy and bandwidth remain as the standard today. However, Shannon did not address the content, only what the data is. The coding will expand the definition of this code to include meaning,

(Al-Fedaghi, 2012) (Cronin, Parker, Colleran, & Gold, 1991) (Danaher & Rossiter, 2011) (Flensburg, 2010) (Gerbner, 1956) (Klüver, 2011) (Lasswell, 1948) (Lasswell, 1951b) (Lasswell, 1951a) (Lasswell, 1952) (Ma, 2012) (C. E. Shannon, 1948a) (C. E. Shannon, 1948b) (C. E. Shannon & Weaver, 1949) (Westley & MacLean Jr, 1955)

Axiom: Centrality Proposition: Control	
Short Description	The process by means of which a whole entity retains its identity and/or performance under changing circumstances.
Detailed Description	Management control systems provide information that is intended to be useful to managers in performing their jobs and to assist organizations in developing and maintaining viable patterns of behaviour.
Inclusion Criteria	Is the function designed/intended/expected to provide the organization capability to make decisions/execute actions that will enable it to remain viable?
Exclusion Criteria	Does the function not serve to enable the organization to make/execute decisions that enable it to remain viable?
Typical Exemplars	Management processes that collect data/information to enable making decisions.
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Not discussed
How is it related to the proposition?	It is the proposition.
What features or principles are being drawn out?	The requirement for two components - monitoring activity which compares criteria by which system performance is judged and a control action that is dependent on the monitoring.
What specific details are being discussed?	The different approaches to control, with the Soft Systems (AI) bias.
How does this translate to the competency framework?	Need to address both the "hard" and "soft" aspects of control
Does a different axiom or proposition also get referenced?	Many
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Extensive discussion of assumptions Including that systems exist in the world, they can be defined as goal seeking, and they could be controlled (pg 48) as well as contrasting assumptions in Appreciative Systems theory: there are relationships to be maintained, as well as eluded; there are multiple and mutually inconsistent courses being plotted (goals),
What did I learn from this document?	Relearned the importance of distilling - pgA53 - distilling 26 relevant systems into

	a model that easily and clearly explained the ILSD function as a wealth generating component of ICI.
Why did I include this document?	Well thought out approach to control (though soft biased)
Was there a surprise?	No.
Did I see other areas to explore?	Do not miss the 'hard' perspective of control
Is a new code or codes required?	No
Summary: The proposition of control is an important element of the competency model framework. The two perspectives will need to be captured.	

(Amit & Schoemaker, 1993) (Athans, 1987) (Bar-Yam, 2004) (Bierly & Spender, 1995) (Burgelman, 1983) (Checkland, Forbes, & Martin, 1990) (Checkland, 1993) (Dillard & Nehmer, 1990) (Dubinskas, 1993) (Ender et al., 2010) (Espinosa, et al., 2007) (Hennessy Jr, 1960) (Johnson, Kast, & Rosenzweig, 1964) (Kapsali, 2011b) (Koskela & Vrijhoef, 2000) (Lebow, 2006) (Lee, Kim, & Lee, 2011) (Manuele, 2008) (Mariani, 2004) (McCabe, 1976) (McClelland, 1973) (D. Miller, 1987) (Noonan, 2007) (Ntuen, Munya, Trevino, Leedom, & Schmeisser, 2010) (Odell, 2002) (Otley, 1999) (Pask, 1964) (Ronn, 2011) (Rouse, 2000) (Schutz, 1958) (Markus Schwaninger, 2000) (Warfield, 2003) (G. A. Williams & Miller, 2002) (Zachman, 1987) (Zhou, Zhang, Salzberg, Cooperman, & Kollios, 2005)

Axiom: Centrality Proposition: Emergence	
Short Description	For all things that have more than one part, and of which the sum is not like a heap, but a whole that is something over and above the parts, have something that is responsible for them; since among the bodies, the cause of the being -one of some of them is contact, and of others stickiness or some other attribute of that sort. (Sachs, 1999, pp. 163-164)
Detailed Description	One group of ideas are manifest in the statement that emergent properties are "novel" and "unpredictable" from knowledge of their lower level bases, and that they are not "explainable" or "mechanistically reducible" in terms of their underlying properties. (Kim, 1999, p. 5) The second group of ideas I have in mind comprises the specific emergentist doctrines concerning emergent properties, and, in particular, claims about the causal powers of the emergents. Prominent among them is the claim that the emergents bring into the world new causal powers of their own, and, in particular, that they have powers to influence and control the direction of the lower-level processes from which they emerge. (Kim, 1999, pp. 5-6)
Inclusion Criteria	Can the properties of the *level of interest* be predicted from an analysis of the level below? If not, then emergence has occurred.
Exclusion Criteria	Can the properties of the *level of interest* be predicted from an analysis of the level below? If so, then emergence has not occurred.
Typical Exemplars	Humans, a sphere (Aristotle's examples)
Atypical Exemplars	Not Required
Close, but No	A heap of sand

How is the axiom being discussed?	Axiom was not invoked by Aristotle
How is it related to the proposition?	Directly describes the proposition of emergence by the existence of a whole that is more than the sum of its parts, as opposed to a whole comprised merely of its parts (a heap).
What features or principles are being drawn out?	Very brief discussion of the emergence associated with humans and spheres. The sphere itself is now responsible for its properties, not some external source.
What specific details are being discussed?	Aristotle was immediately drawn to the existence of humans, as not animals. Thus he combines rationality with animalness and

	humans arise.
How does this translate to the competency framework?	The long history of the idea of emergence, coupled with the new work in social systems implies that emergence is a key component of systems competency
Does a different axiom or proposition also get referenced?	Communication - dialectic discussion Holism - pages 163-164 Circular Causality - Page 10 Equifinality/multifinality - hints pp 162-163
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Aristotle used previous chapters to describe his assumptions
What did I learn from this document?	This lead to readings on weak and strong emergence, as well as the philosophical implications for a competency model framework from Koskela, Rooke and others
Why did I include this document?	Earliest examination of emergence
Was there a surprise?	The other principles noted above, but not necessarily using the modern terms.
Did I see other areas to explore?	The difference between strong emergence and weak emergence
Is a new code or codes required?	No
Summary: Emergence is a key element of the competency framework because it captures the elements of surprise when a system is created or instantiated with properties that were not predictable. An organization needs the ability to respond to such surprises,	

(Abbott, 2006) (Adams & Keating, 2009) (Bella, King, & Kailin, 2003) (Bloom, 2002) (Brodu, 2008) (Chalmers, 2006) (Clayton, 2006) (Clayton & Davies, 2006) (P. A. Corning, 2002) (Fioretti & Visser, 2004) (Halley & Winkler, 2008) (Harré, 2006) (Hirschheim & Klein, 1992) (Hu, 2008) (Kan & Parry, 2004) (Kim, 1999) (Kitto, 2008) (Koskela, Rooke, & Siriwardena, 2009) (Koskela & Vrijhoef, 2000) (Kubovy & van den Berg, 2008) (Lichtenstein & Plowman, 2009) (Lundvall, Johnson, Andersen, & Dalum, 2002) (Gerald Midgley, 2008) (Osberg & Biesta, 2007) (Prokopenko, Boschetti, & Ryan, 2009) (K. A. Richardson, 2004a) (K. A. Richardson, 2005b) (K. A. Richardson, 2007b) (R. C. Richardson, 2001) (Rooke, Koskela, & Seymour, 2006) (Ryan, 2006) (Ryan,

2007) (Sachs, 1999) (Solow, 2001) (Sousa-Poza, Padilla, & Bozkurt, 2008) (Turner, 2008)

Axiom: Centrality Proposition: Hierarchy	
Short Description	"... the natural way to achieve simplicity or efficiency in a large collection of interacting elements." (Pattee, 1973, p. 73)
Detailed Description	"The elegance of a physical theory depends on simplicity, but never on simplicity alone. There must also be a measure of effectiveness. In the same way, the simplification that results from the hierarchical constraints of an organization must be balanced by how well it functions."(Pattee, 1973, p. 73)
Inclusion Criteria	Is there a set of levels? Do they balance the function to the constraints?
Exclusion Criteria	Is the organization flat? no apparent levels?
Typical Exemplars	Any military organization,
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Not discussed
How is it related to the proposition?	Is the proposition
What features or principles are being drawn out?	The proposition of hierarchy brings two paradoxes: Limit freedom and give more freedom at the same time; They always appear arbitrary to some extent
What specific details are being discussed?	Defines Constraint: A forcible limitation of freedom
How does this translate to the competency framework?	Since organizations are hierarchical, some element must be present in the competency model framework
Does a different axiom or proposition also get referenced?	Communications, Control, Holism, MCS (synonym), Self-organization and feedback
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Assumes that there is no other choice, and thus rushes past why
What did I learn from this document?	Tightly coupled to control
Why did I include this document?	Early development of Hierarchy Theory as a distinct field
Was there a surprise?	No
Did I see other areas to explore?	Relationship to control
Is a new code or codes required?	No

Summary: Hierarchy literature has not turned over why hierarchy develops, other than we (humans, as well as many living creatures) appear to be wired for it.

(Bar-Yam, 2004) (Espinosa, et al., 2007) (Hornby, 2007) (Manuele, 2008) (Norton, 1990) (E. G. O'Neill, O'Neill, & Norby, 1991) (R. V. O'Neill, 1985) (Pattee, 1973) (K. A. Richardson, 2004b) (Salthe, 2004) (Salthe, 2007) (Simon, 1962) (Simon, 1977) (Troncale, 2009) (Tuan, 2010) (Turchin & Daniels, 1981) (Umerez, 2001)

Axiom: Contextual Proposition: Complementarity	
Short Description	Two different perspectives or models about a system will reveal truths regarding the system that are neither entirely independent nor entirely compatible.
Detailed Description	Indeed this circumstance presents us with a situation concerning the analysis and synthesis of experience which is entirely new in physics and forces us to replace the ideal of causality by a more general view-point usually termed "complementarity." The apparently incompatible sorts of information about the behavior of the object under examination which we get by different experimental arrangements can clearly not be brought into connection with each other in the usual way, but may, as equally essential for an exhaustive account of all experience, be regarded as "complementary" to each other. In particular, the frustration of every attempt to analyze more closely the "individuality" of single atomic processes, symbolized by the quantum of action, by a subdivision of their course, is explained by the fact that each section in this course definable by a direct observation would demand a measuring arrangement which would be incompatible with the appearance of the uniformities considered. (Niels Bohr, 1937)
Inclusion Criteria	disquietude of many physicists and philosophers, we have met in atomic physics. The other aim was to express the hope that the epistemological attitude which had led to the clarification of the much simpler physical problems could prove itself helpful also in the discussion of psychological questions. In fact, the use which we make of words like "thought" and "feeling," or "instinct" and "reason" to describe psychic experiences of different types, shows the existence of characteristic relationships of complementarity conditioned by the peculiarity of introspection. Above all, just the impossibility in introspection of sharply distinguishing between subject and object as is essential to the ideal of causality would seem to provide the natural play for the feeling of free will.(Niels Bohr, 1937)
Exclusion Criteria	Is there only one point of view? If so, there is no complementarity at work.
Typical Exemplars	Initially applied to atomic processes, Bohr sought to expand to a number of fields - psychology, sociology
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Complementarity is dependent on at least two different representations of context,

	creating differing worldviews of the particular situation
How is it related to the proposition?	It is the proposition
What features or principles are being drawn out?	The requirement for at least two different perceptions of reality, either at the epistemological or ontological level, with both being "true". This gives rise for a desire to be able to use both views in the problem solving portion of the effort
What specific details are being discussed?	Numerous occasions of how complementarity started in quantum physics but has been expanded to other fields.
How does this translate to the competency framework?	How does the competency model reflect the ability to: 1) recognize the different perspectives? 2) not reject one or the other? 3) use both truth versions (even if they appear contradictory) in the solution set?
Does a different axiom or proposition also get referenced?	Emergence, autopoiesis, self organization
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Some hidden, drawn out in later works
What did I learn from this document?	The wide ranging use of the concept of complementarity. The still unanswered questions of QD
Why did I include this document?	Root document
Was there a surprise?	Yes - different perspectives of Bohr and Heisenberg
Did I see other areas to explore?	Other fields that have complementarity expressed - psychology, sociology
Is a new code or codes required?	No
Summary: Complementarity expresses a fundamental skill that appears to be required. Add the research on the lack of certainty, and there will be more "truths". This seems to be a required element in the framework model.	

(Billingsley, Taber, Riga, & Newdick, 2012) (Niels Bohr, 1950) (N. J. Curtis, Dortmans, & Ciuk, 2006) (Derry, 2005) (Emery, 2000) (Feyerabend & McKay, 1958) (Goguen & Varela, 1979) (Holton, 1970) (Holton, 1988) (Howard, 2004) (Jutoran, 1994) (S. L.

Payne, 1994) (Popper, 1967) (Sharpe, 1982) (Sharpe, 1991) (Sharpe, 2003) (Spaulding, 1933) (Ulrich, 2003) (von Stillfried, 2010) (Walach & Romer, 2000)

Axiom: Contextual Proposition: Darkness	
Short Description	Each element in the system is ignorant of the behavior of the system as a whole.
Detailed Description	It responds only to information that is available to it locally. This point is vitally important. If each element 'knew' what was happening to the system as a whole, all of the complexity would have to be present in that element
Inclusion Criteria	Are their elements of the system that are incapable of knowing all the other elements of the system
Exclusion Criteria	Can we describe the system as simple or complicated rather than complex
Typical Exemplars	Veterans Benefits assignment of rating system "Abolishment of Welfare as we know it"
Atypical Exemplars	Not required
Close, but No	Not required

How is the axiom being discussed?	The contextual elements provide the complexity that contribute to the impossibility of knowing all the elements of the system
How is it related to the proposition?	It is the definition
What features or principles are being drawn out?	How the inability to know all the features of the system gives rise to emergence or emergence gives rise to darkness
What specific details are being discussed?	There is a related concept of incompressibility which might better describe the terms - the inability to describe the complex system in terms of less elements than are present - in other words, the complex system cannot be reduced
How does this translate to the competency framework?	This is a key concept for the competency framework, as the large trend towards reduction would be completely overwhelmed by the incompressibility. This might also contribute to repeated failures due to emergence or other principles
Does a different axiom or proposition also get referenced?	Yes - emergence, self organization, purposive behavior
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Relatively visible

What did I learn from this document?	The term may be better expressed as incompressibility rather than darkness
Why did I include this document?	Source Document
Was there a surprise?	Yes - the relative paucity of material - however, it appears to be growing
Did I see other areas to explore?	Touches on psychology, hydrology (again), The concept of boundaries as a principles
Is a new code or codes required?	Discinyms – incompressibility, ignorance
Summary: The relationship of the context drives the complexity of the problem - complexity id required for darkness otherwise the problem is either simple or complicated - references to Snowden like terms, but not a reference to Cynefin literature	

(Cilliers, 1998) (Coburn, 2008) (Eckschlager & Štěpánek, 1987) (R. Geyer, 2003) (Gibson, 2006) (Harrison, 2009) (Mason, 2008) (K. A. Richardson, 2007a) (K. A. Richardson, Cilliers, & Lissack, 2000) (K. A. Richardson, Mathieson, & Cilliers, 2000) (K. A. Richardson & Tait, 2010) (Walther, Kellam, Sochacka, & Radcliffe, 2011) (Yorks, 2013)

Axiom: Contextual Proposition: Holism	
Short Description	The whole is not something additional to the parts: (Smuts, 1926)
Detailed Description	It is the parts in a definite structural arrangement and with mutual activities that constitute the whole. The structure and the activities differ in character according to the stage of development of the whole; but the whole is just this specific structure of parts with their appropriate activities and functions
Inclusion Criteria	Does the feature arise only when the whole is assembled?
Exclusion Criteria	Does it exist at some lower level of hierarchy
Typical Exemplars	An automobile is the whole, but the parts cannot function without being assembled The political process, including all the elements (donations, interest groups, the press, and so on)
Atypical Exemplars	Not required
Close, but No	Not required

How is the axiom being discussed?	Context frames the system, and allows for holism
How is it related to the proposition?	Is the proposition
What features or principles are being drawn out?	See references
What specific details are being discussed?	See references
How does this translate to the competency framework?	It is clear that understanding the implications of holism is required for the competency model
Does a different axiom or proposition also get referenced?	Numerous - communication, control, emergence, hierarchy
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	Creativity is actually an outcome of holism, and this cycle of holism giving rise to creativity creates larger wholes
Why did I include this document?	Source
Was there a surprise?	Yes, the discussion on creativity
Did I see other areas to explore?	Potentially equilibrium
Is a new code or codes required?	No
Summary: The mind is an organism of wholes. "The theory of Holism thus carries the scientific system of experience another step further and the tries to read in the riddle of Science sill deeper and more ultimate concepts of reality" (P248)	

(Aristotle, 2002) (see Sachs) (Bertalanffy, 1950a) (Bertalanffy, 1950b) (Bertalanffy, 1953) (François, 1999) (Gallagher & Appenzeller, 1999) (Jackson, 1985) (Jackson, 1990)

(Jackson, 2000) (Jackson, 2003a) (Jackson & Keys, 1984) (Klir, 2005) (Kwa, 2002) (Latour, 2002) (Latour, 2004) (Law, 2004) (Law, 2004b) (Law, 2008) (Law, 2009) (Law, 2011) (L. M. Miller, 1994) (Mulej, 2007) (Risan, 2006) (Susman & Evered, 1978) (Turnbull, 1997) (Udehn, 2002) (Ulrich, 1993) (Urry, 2005) (Wimsatt, 1972) (Zeleny, 1987)

Axiom: Design Proposition: Minimum Critical Specification	
Short Description	This principle has two aspects, negative and positive. The negative simply states that no more should be specified than is absolutely essential; the positive requires that we identify what is essential.
Detailed Description	It is of wide application and implies the minimum critical specification of tasks, the minimum critical allocation of tasks to jobs or jobs to roles, and the specification of objective with minimum critical specification of methods of obtaining them. While it may be necessary to be quite precise about what has to be done, it is rarely necessary to be precise about how it is to be done.
Inclusion Criteria	Does the description provide the minimum information about how?
Exclusion Criteria	Is the solution constrained by the specifications to one or few outcomes?
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	MCS is crucial to the design of any system.
How is it related to the proposition?	MCS is the proposition
What features or principles are being drawn out?	Cherns discusses MCS at a high level, leaving lots for other authors
What specific details are being discussed?	Cherns discusses MCS at a high level, leaving lots for other authors
How does this translate to the competency framework?	While it is translatable, Cherns provides little guidance. However, it appears to be an important part of the framework
Does a different axiom or proposition also get referenced?	Control, Information, Multifinality/Equifinality by extension of the MCS principle
Does the text indicate a missing axiom or proposition that should be added?	Possibly a proposition on Boundaries
Are the assumptions visible or are there hidden assumptions?	Assumptions are lightly touched upon.
What did I learn from this document?	The expansive number of fields that MCS can be applied
Why did I include this document?	Source
Was there a surprise?	No
Did I see other areas to explore?	Search for ways to know how to implement MCS
Is a new code or codes required?	No
Summary: MCS provides a high level guidance which will require skill and experience to implement. Cherns does not provide a real rule set for knowing how to identify just the MCS. None of the references really provides detailed guidance; they mostly echo the original guidance. It seems that a wider search might uncover some case studies, but this could be a fruitful area for research. At the same time, the Navy and the ship building industry has expressed interest in	

examining how their specifications drive the cost of ship construction...

(Aragon & Hearst, 2005) (Bjarnason, Wnuk, & Regnell, 2012) (Bostrom, 1980) (Cherns, 1976) (Cherns, 1987) (Dillard & Nehmer, 1990) (Dubinskas, 1993) (Harker, Eason, & Dobson, 1993) (Kapsali, 2011b) (Kapsali, 2011a) (Keating, Kauffmann, & Dryer, 2001) (Mulvihill & Keith, 1989) (Mumford, 1994) (Nerur & Balijepally, 2007) (Ngwenyama, 1993) (Noble, 2000) (O'Sullivan, 2002) (Robinson, 1982) (Siemieniuch & Sinclair, 2006) (Telem, 1988a) (Telem, 1988b) (Wastell & White, 2013) (Weisbord, 1985)

Axiom: Design Proposition: Pareto	
Short Description	Eighty percent of the objectives or outcomes are achieved with twenty percent of the means. (Pareto, 1897)
Detailed Description	My 1971 translation provides no insights
Inclusion Criteria	Does the organization's system provide for a method to determine the leverage available from resources? This will help determine which are key resources, and which are not. This has also been a driver for "Business Process Improvement" and "Re-engineering the Corporation". The question of how much slack is required is being debated today. Does the organization know which resources provide the most leverage to business results?
Exclusion Criteria	Organizations that do not determine which resources provide leverage.
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	The provision of resources is key in organization design
How is it related to the proposition?	Is the proposition
What features or principles are being drawn out?	How to determine pricing
What specific details are being discussed?	Social implications of theory
How does this translate to the competency framework?	Organizations must understand how to allocate resources and leverage them. At the same time, having sufficient capacity to respond to either the market or other shocks is required for success
Does a different axiom or proposition also get referenced?	Yes
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	Extensive discussion of early economics theory
Why did I include this document?	Seminal
Was there a surprise?	No
Did I see other areas to explore?	Yes
Is a new code or codes required?	No
Summary: The source document is very indirect, other references are required to 'translate' its meaning	

(Bag & Pepito, 2012) (Berliant & Fujita, 2008) (Bommier & Zuber, 2012) (Brusco, 2002) (Brynjolfsson, Hu, & Simester, 2011) (Carare, 2012) (Chang, 2000) (Coughlin, 1986) (Duclos, Makdissi, & Wodon, 2008) (Fleurbaey, Tungodden, & Chang, 2003) (Galenianos & Kircher, 2012) (Huck, Normann, & Oechssler, 2004) (Kaplow & Shavell, 2001) (Lang & Majumdar, 2004) (Lopreato & Rusher, 1983) (Mailath & Postlewaite, 2006) (Ohlendorf & Schmitz, 2012) (Pareto, 1897) (Prescott & Ríos-Rull, 2005) (Ronen & Starr, 1990) (Runkel & Schjelderup, 2011)

Axiom: Design Proposition: Requisite Parsimony	
Short Description	Human short-term memory is incapable of recalling more than seven plus or minus two items. (Simon, 1974)
Detailed Description	How do people reduce immense search spaces to reasonable proportions? Thus asks Simon in his 1974 paper, expanding on Miller's paper on the Magic number seven plus or minus two
Inclusion Criteria	Does the system allow the decision makers to reduce what can be an infinite number of choices to a 'reasonable' set?
Exclusion Criteria	Does the system ignore the capability limits of the decision maker?
Typical Exemplars	Providing more chunks than a human can handle, as opposed to well designed number of alternatives
Atypical Exemplars	McDonalds menu as compared to Peters Restaurant (literally over 200 menu choices)
Close, but No	

How is the axiom being discussed?	The system must be designed to capitalize on the capacity of the decision makers. Deviance from this will decrement the decision makers' chances of making good choices
How is it related to the proposition?	It is the proposition
What features or principles are being drawn out?	Discussion of how chunk size was developed, relationship to real decision making
What specific details are being discussed?	Learning Time, Fixed number of chunks limit
How does this translate to the competency framework?	If the organization and its people do not recognize the chunk limit, the methods used to present data and decisions will likely not produce good decisions due to the confusion introduced.
Does a different axiom or proposition also get referenced?	Not directly
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Reviews assumptions
What did I learn from this document?	The search for 'invariants' in these relationships is difficult and not assured
Why did I include this document?	Seminal paper
Was there a surprise?	Yes - treatment of the problem as a parameter estimation problem rather than hypothesis testing paradigm - theory building rather than theory testing.
Did I see other areas to explore?	Other invariants
Is a new code or codes required?	No
Summary: Requisite Parsimony grew out of research seeking to understand cognitive processes. While this paper did not directly address the implications, it lays the ground work for understanding cognitive limits in decision making.	

(Bausch, 2010) (Bausch & Flanagan, 2013) (Broome & Fulbright, 1995) (Broome & Keever, 1989) (Alexander N Christakis, 2001) (Alexander N Christakis & Brahms, 2003) (J. P. Day, 1975) (Laouris & Christakis, 2007) (Mar, 1996) (Matjaz, Stefan, & Vojko, 2005) (G. Miller, 1956) (Perrin, Michel, & Andréassian, 2003) (Simon, 1974) (Warfield, 1996) (Warfield & Cárdenas, 1994)

Axiom: Design Proposition: Requisite Saliency	
Short Description	The factors that will be considered in a system design are seldom of equal importance. Instead, there is an underlying logic awaiting discovery in each system design that will reveal the saliency of these factors.(Boulding, 1966)
Detailed Description	Not Required
Inclusion Criteria	Does the organization's systems provide for a systemic (and perhaps systematic) way to order choices?
Exclusion Criteria	Is everything equally important?
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	One of three ways that decisions get screwed up, detracting from decision making ability
How is it related to the proposition?	Is the proposition
What features or principles are being drawn out?	Boulding focused on the spurious saliency. Things that are not important but attract our focus.
What specific details are being discussed?	The squeaky wheel gets the grease, noisy and troublesome people get attention
How does this translate to the competency framework?	Can the organization and its people make decisions of which problems, or initiatives or projects are more important than others and then ignore the chaff to focus on what is important?
Does a different axiom or proposition also get referenced?	This text hints at requisite parsimony
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible as well as his biases
What did I learn from this document?	Boulding approached this from the back end - focusing on spurious saliency. He offered no prescriptions
Why did I include this document?	Seminal paper
Was there a surprise?	No
Did I see other areas to explore?	Yes - ordering of decisions
Is a new code or codes required?	No
Summary: Boulding's treatment of saliency focused on the non-salient, but leads others to look at saliency from the decision making perspective - there was limited literature on this topic using the term Requisite Saliency - there is a lot more on decision making, but I chose not to expand the net very far.	

(Boulding, 1966) (Alexander N. Christakis, 2004) (Dong, 2002) (Georgiou, 2010) (Greenwood & Sommerville, 2011) (Hogan, 2006) (Laouris, Michaelides, & Sapio, 2008) (Laouris & Siitta-Achileos, 2010) (Simpson & Simpson, 2006) (Warfield, 2009) (Yufa, Leping, Min, & Jinsen, 2013) (Zhao, 2009)

Axiom: Goal Proposition: Equifinality	
Short Description	If a steady state is reached in an open system, it is independent of the initial conditions, and determined only by the system parameters, i.e. rates of reaction and transport. (Bertalanffy, 1950a)
Detailed Description	The open system has the capability to reach the same state by multiple paths, using feedback, control and other principles.
Inclusion Criteria	Does the organization and its people have methods to redirect resources when the gap between goal and actual is growing larger? or not smaller fast enough?
Exclusion Criteria	Organizations that act as open loops. Conditions change, but the actions don't and thus goals are not achieved
Typical Exemplars	Most successful businesses
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	The idea of a goal is required to even know that equifinality is possible, otherwise you just end up where you are
How is it related to the proposition?	It is the proposition
What features or principles are being drawn out?	Control, feedback, purposive behavior, requisite hierarchy and several other principles
What specific details are being discussed?	Mechanisms span a wide range in order for the organization to achieve equifinality
How does this translate to the competency framework?	Having people that can achieve the goal, despite changes in conditions (both endogenous and exogenous) is required for the organization to achieve its goals
Does a different axiom or proposition also get referenced?	Control, feedback, purposive behavior, requisite hierarchy and several other principles
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	Wide applications of the principle
Why did I include this document?	Seminal paper
Was there a surprise?	Wide applications of the principle, coupled with the intense discussions in some of the literatures
Did I see other areas to explore?	Yes
Is a new code or codes required?	No
Summary: Equifinality has migrated to a wide number of fields: OD, Hydrology and psychopathology to name three. In some it threatens the carefully constructed edifices, since it points to fundamental problems with the underlying theory.	

(Beauchaine, 2003) (Bergman, Andershed, & Andershed, 2009) (Beven, 2006) (Beven & Freer, 2001) (Cicchetti & Rogosch, 1996) (Cloninger, Svrakic, & Svrakic, 1997) (Culling, 1987) (W. J. Curtis & Cicchetti, 2003) (Davidsson, Achtenhagen, & Naldi, 2010) (Doty, Glick, & Huber, 1993) (Drazin & Ven, 1985) (Frick & Viding, 2009) (George & Smoke, 1989) (Gresov & Drazin, 1997) (Kapsali, 2011b) (Mantovan & Todini, 2006) (D. Miller, 1981) (D. Miller, 1987) (Mintzberg, 1978) (G. T. Payne, 2006) (Perrin, et al., 2003) (Perrow, 1967) (Richters, 1997) (Sumner, 1910)

Axiom: Goal Proposition: Multifinality	
Short Description	Radically different end states are possible from the same initial conditions. (Buckley, 1967)
Detailed Description	Radically different end states are possible from the same initial conditions.
Inclusion Criteria	Do the outcomes turn out differently starting from seemingly identical conditions?
Exclusion Criteria	Starting from dissimilar conditions is different - not multifinality
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	When attempting to reach the goal, small, seemingly unimportant differences in either starting conditions or along the way can dramatically alter the outcome. Those small differences may be noted, but often are not until the untoward outcome occurs and the faultfinding begins.
How is it related to the proposition?	Is proposition
What features or principles are being drawn out?	The difficulty in discerning which small differences will have significant impact on the outcome or end result.
What specific details are being discussed?	How do small, seemingly inconsequential, differences result in dramatically different trajectories and outcomes? The concept of bifurcations has also been touched upon discussing multi-finality
How does this translate to the competency framework?	Sensitivity to both starting condition differences and small differences along the way is required to achieve desired outcomes when seemingly starting singing initial conditions. Organizations need people with the skills to discern those differences when building competency models.
Does a different axiom or proposition also get referenced?	Context also seems to play a large role.
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there	Buckley's treatment, as is common for this

hidden assumptions?	topic, is very light and the assumptions are not visible.
What did I learn from this document?	Buckley's treatment needs to be expanded; however, he uses the term 'deviation-amplifying transaction' which seems useful.
Was there a surprise?	Yes - the lack of real theory of why this occurs
Did I see other areas to explore?	Need to explore multifinality roots of the theory.
Is a new code or codes required?	No
Summary: The small differences that turn into huge differences at the outcomes, and the time required to get there mean it is hard to tell which small differences matter.	

(Beauchaine, 2003) (Bergman, et al., 2009) (Black, 2009) (Buckley, 1967) (Cicchetti & Rogosch, 1996) (Cloninger, et al., 1997) (W. J. Curtis & Cicchetti, 2003) (Dooley, 1999) (Frick & Viding, 2009) (Jokela, Karlsudd, & Östlund, 2008) (Kennedy, Chan, Fok, & Yu, 2008) (Kruglanski, 2006) (Richters, 1997) (Warren, Franklin, & Streeter, 1998)

Axiom: Goal Proposition: Purposive Behavior	
Short Description	Purposeful behavior is meant to denote that the act or behavior may be interpreted as directed to the attainment of a goal-i.e., to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event. (Rosenblueth, et al., 1943)
Detailed Description	Purposeful act of behavior may be subdivided into two classes: "feedback" (or teleological") and "non-feedback" (or non-teleological). Expression feedback is used by engineers in two different senses. In a broad sense it may denote that some of the output energy of an apparatus one machine is returned as input; an example is electrical and fire with feedback. Feedback is in these cases positive – the fraction of the output which reenters the object has the same sign as the original input signal. Positive feedback adds to the input signals, it does not correct them. The term feedback is also employed in a more restricted sense to signify that the behavior of an object is controlled by the margin of error at which the object stands at a given time with reference to a relatively specific goal. The feedback is been negative, that is, the signals from the goal are used to restrict outputs which would otherwise go beyond the goal. It is this second meaning of the term feedback that is used here.
Inclusion Criteria	Does the system compare where it is compared to the goal and take action to get to get to the goal?
Exclusion Criteria	Is the system an open loop?
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	The idea of the goal is the source of the concept of feedback.
How is it related to the proposition?	Feedback arises as a result of mismatch between the current state and the goal state.
What features or principles are being drawn out?	The relationship of purpose and goal is required to understand the origin of feedback.
What specific details are being discussed?	Feedback is further subdivided between extrapolative (predictive) and non-extrapolative (non-predictive)
How does this translate to the competency framework?	The ability to discern, use, modify, and understand feedback is essential to the

	organization meeting its goals. Thus competency with feedback is a required element of the competency model.
Does a different axiom or proposition also get referenced?	Communication, control, temporal relationships
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	The authors lay down their assumptions early, there do not appear to be other assumptions required to reach their conclusions.
What did I learn from this document?	A new use of the word teleology, separate from the normal metaphysical use.
Why did I include this document?	Seminal document
Was there a surprise?	The separation between functional relationships and causality.
Did I see other areas to explore?	No
Is a new code or codes required?	No
Summary: purposive behavior is a result of organizations, people having goals and taking actions to attain those goals, thus arises the purposive behavior. The gap between the goal and the current state requires feedback to the system which implies a control system in order to close the gap.	

(Ackoff & Emery, 2006) (Ansoff & Brandenburg, 1971a) (Ansoff & Brandenburg, 1971b) (Churchman & Ackoff, 1950) (DeLaurentis & Callaway, 2004) (Emery, 2000) (Hideg, 2007) (G. M. Hodgson, 1991) (Laszlo, 1986) (Marken, 1990) (Mele, Pels, & Polese, 2010) (Pomerol, 1998) (K. A. Richardson, 2005a) (Rosenblueth, et al., 1943) (Stone & Veloso, 2000) (R. A. Swanson, 1999) (Tschacher & Haken, 2007) (Van Lamsweerde, 2001) (Vancouver, 1996)

Axiom: Goal Proposition: Satisficing	
Short Description	The decision making process whereby one chooses an option that is, while perhaps not the best, good enough. (Simon, 1955) (Simon, 1956)
Detailed Description	Broadly stated task is to replace the global rationality of economic man with the kind of rational behavior that is compatible and access to information and consultation of capacities that are actually possessed by organisms, and man in the kinds of environments in which organisms exist.(Simon, 1955)
Inclusion Criteria	Do the decision-makers come to their decision using all information available, or do they make the decision based on a fraction of the knowledge available.
Exclusion Criteria	Some decision-support processes enable exhaustive examination of the alternatives. The decision would presumably be an optimal rather than satisficing.
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	The organization has goals which require decision-making to achieve. The decisions concern allocation of resources schedules people and use of time.
How is it related to the proposition?	The process to reach those decisions can attempt to be exhaustive, "maximization" or it can use sufficient information to make the best decision possible based on that limited data set.
What features or principles are being drawn out?	How satisficing is different from optimization, How satisficing may increase the robustness or reduce the fragility of the organization.
What specific details are being discussed?	Use of satisficing to develop decision making skills
How does this translate to the competency framework?	Decision makers can use satisficing to their advantage when design and leading an organization
Does a different axiom or proposition also get referenced?	Viability, emergence
Does the text indicate a missing axiom or proposition that should be added?	No

Are the assumptions visible or are there hidden assumptions?	Mostly visible
What did I learn from this document?	See summary
Why did I include this document?	Seminal
Was there a surprise?	No
Did I see other areas to explore?	Bounded rationality
Is a new code or codes required?	No
Summary: Satisficing is an effective proposition to improve the stability, as well as reduce the fragility of an organization	

(Checkland, 1985) (R. H. Day, 1984) (DiMario, Boardman, & Sauser, 2009) (Gregor, 2006) (Habbershon, Williams, & MacMillan, 2003) (Hevner, March, Park, & Ram, 2004) (Hollnagel, 2000) (Louvieris, Gregoriades, & Garn, 2010) (March, 1978) (Marczyk, 2000) (Matsuda & Takatsu, 1979) (Nixon, 1993) (Pomerol, 2001) (Sakawa & Yano, 1990) (Siemens, 2005) (Simon, 1979)

Axiom: Goal Proposition: Viability	
Short Description	A function of balance must be maintained along two dimensions: (1) autonomy of subsystem versus integration and (2) stability versus adaptation. (Beer, 1979)
Detailed Description	Discussion of the autonomy and integration on page 202. Integration - the minimal intervention that is consistent with cohesiveness within the purposes of the viable system. Purposes are not objective properties. Discussion of stability and adaptation within the context of relaxation time on page 390. Adaptation means learning, a requirement for continued viability
Inclusion Criteria	Does the organization contain the required elements (System 1, 2, 3, 3*, 4, 5) and are they in necessary balance?
Exclusion Criteria	Does the organization lack a particular element or is one so powerful it dominates to the detriment of the organization?
Typical Exemplars	Typical military hierarchy of commands, many large businesses
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Inherent in any viable system is the goal to survive. This can mean more that survival in some low state, but can include more robust interpretations of 'survive'
How is it related to the proposition?	The very continued existence of the organization (system) demonstrates its viability.
What features or principles are being drawn out?	The requirements for the entirety of the elements to be present, otherwise the organization struggles and may end
What specific details are being discussed?	What are the required elements for an organization to continue to exist, but really more than survive, to thrive?
How does this translate to the competency framework?	How does the organization deal with the human tendency to concentrate power and follow the maxim "if a little of something is good, then a lot of something is better"?
Does a different axiom or proposition also get referenced?	Recursion, relaxation time, communication, control, redundancy
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Quite extensively discussed

What did I learn from this document?	The theme of balance is reoccurring
Why did I include this document?	Seminal
Was there a surprise?	No
Did I see other areas to explore?	Many
Is a new code or codes required?	No
Summary: There are many elements required for an organization to be viable, and they must be at the appropriate level for the particular challenges in front of the organization. This is different from balanced, which was an earlier perspective. And the levels must change over time as the environment and the personnel change.	

(Aulin-Ahmavaara, 1987) (Barile & Polese, 2010) (Beer, 1994) (Beer, 2002) (Brewis, 2004) (Colman, Han, Colman, & Han, 2005) (Daft & Wiginton, 1979) (De Vries, 2008) (Foerster, 1981) (Gershenson, 2006) (Järvinen, 2000) (Klein, 2008) (Koskela, 2011) (Koskela & Howell, 2002) (Koskela & Kagioglou, 2005) (Koskela, et al., 2009) (Markus Schwaninger, 1997) (Markus Schwaninger, 2006) (Stokes, 2004) (Stokes, 2006) (Troncale, 2006)

Axiom: Information Proposition: Information Redundancy	
Short Description	The number of bits used to transmit a message minus the number of bits of actual information in the message.
Detailed Description	How do multiple, simultaneously present cognitive structures influence the representation and recall of social information? In an empirical study examining both free and cued recall, we found the variable information redundancy to influence both the organization and accuracy of subjects' recollections of trait-related behaviors. Redundancy was defined in terms of the degree of person/trait overlap in a social information ensemble. Some evidence indicated that this effect is attributable to an increase in the discriminability of the organizational structures during encoding.
Inclusion Criteria	To others, redundancy "implies an over determination of meaning" (Meier, 1962, p. 123) or "is the repetition of a signal" (Smith, 1966, p. 365); the former branches into semantics, and the latter is obviously an over-simplification.
Exclusion Criteria	Not Required
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Relationship of redundancy to social environment, allowing discrimination of characteristics and retention of knowledge
How is it related to the proposition?	Directly discusses the role of redundancy in improving information gain
What features or principles are being drawn out?	As Weaver says, "redundancy generally. . . is the fraction of the structure of the message which is determined not by the free choice of the sender, but rather by the accepted statistical rules governing the use of the symbols in question" (Shannon & Weaver, 1949, p. 104).
What specific details are being discussed?	The theory of communications at the very lowest level, in terms of binary digits (bits)
How does this translate to the competency framework?	The requirement to have successful communications would seem to be a fundamental requirement for competency. All three levels noted by Shannon and Weaver appear to apply.

Does a different axiom or proposition also get referenced?	Not directly - some discussions of the maximum rate and entropy appear to approach the Bohr concepts of complementarity, but they are not discussed directly.
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	The assumptions appear visible, and as the models are expanded to include noise and error checking, they become more visible.
What did I learn from this document?	Fascinating discussion of the theoretical underpinnings of modern communications theory. One can see extensions from the wiring/fiber/radio waves that Shannon was concerned with to spoken and written communications that Weaver discussed.
Why did I include this document?	Source reference
Was there a surprise?	No.
Did I see other areas to explore?	Yes - need to explore the role in personal interactions. This is a key element of the framework.
Is a new code or codes required?	No
Summary: This proposition focuses on the 'extra' information that is required in communications. Without redundancy, there is no error checking, and no feedback mechanism. This proposition has been grabbed by a wide variety of fields, particularly psychology to help explain human interactions, such as initial impression formation.	

(Paul Anderson, 1997) (Cafferty, DeNisi, & Williams, 1986) (Checkland & Holwell, 1998) (Eckschlager & Štěpánek, 1987) (Foste & Botero, 2012) (Garner, 1970) (Hsia, 1977) (Iivari & Hirschheim, 1996) (Iivari, et al., 1998) (Jaeger, 2010) (Kahneman & Tversky, 1972) (Lasswell, 1948) (Mercier & Sperber, 2009) (Mercier & Sperber, 2011) (Mukati, 2011) (Partridge, 1981) (Pask, Scott, & Kallikourdis, 1973) (Pryor, Kott, & Bovee, 1984) (Rosser Jr, 2010) (Sedikides & Ostrom, 1988) (Sperber et al., 2010)

(Tversky & Kahneman, 1971) (Tversky & Kahneman, 1974) (Weaver, 1948) (Yandell, 1982)

Axiom: Information Proposition: Redundancy of Potential Command	
Short Description	"It is a redundancy of potential command wherein knowledge constitutes authority."
Detailed Description	".. the actual control passes from minute to minute from ship to ship, according to which know of communication has then the critical information to commit the fleet to action. This is neither the decentralized command proposed for armies, nor a fixed structure of command of any rigid sort. It is a redundancy of potential command wherein knowledge constitutes authority."
Inclusion Criteria	Does the organization have the ability to 'pass command' to the person or unit that has the knowledge to make the decision?
Exclusion Criteria	Either very hierarchical or disjointed organizations are to be excluded. The hierarchical since the decision must be passed 'up' to be made, and the disjoint since the decision may be made lower down, but this is by accident, not design.
Typical Exemplars	A networked fleet of ships, Nordstrom's sales floor personnel
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Information is the core of the discussion
How is it related to the proposition?	The ability to shift decision-making to the 'appropriate' entity is discussed.
What features or principles are being drawn out?	What are the requirements to be able to have RPC? What must be built into the system to accomplish this?
What specific details are being discussed?	The concept of a reticulum which is a very complex many to many connection
How does this translate to the competency framework?	The ability to distribute the decision making capability to the appropriate level allows speed, responsiveness and engagement.
Does a different axiom or proposition also get referenced?	Redundancy
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Somewhat visible
What did I learn from this document?	Application of RPC extends beyond formal networks
Why did I include this document?	Seminal document

Was there a surprise?	No - but extends to MCS
Did I see other areas to explore?	How does this get done well? What other elements are required to permit this to exist?
Is a new code or codes required?	No
Summary: The ability to distribute the decision making capability to the appropriate level allows speed, responsiveness and engagement, which are good things. This principle needs to be coupled with MCS to be effective.	

(Michael A. Arbib, 1971) (Michael A. Arbib. 1972) (Michael A. Arbib, 2000) (Beer, 2002) (Beer, 2004) (Espejo, 2004) (Husbands & Holland, 2012) (McCulloch, 1959) (Mitterauer & Kopp, 2003) (Nonaka, 1994) (E. G. O'Neill, et al., 1991) (Piccinini, 2004) (K. A. Richardson, Cilliers, et al., 2000) (Scott, 2007) (Srinivasan, 1974)

Axiom: Operational Proposition: Dynamic Equilibrium	
Short Description	For a system to be in a state of equilibrium, all subsystems must be in equilibrium. All subsystems being in a state of equilibrium, the system must be in equilibrium.
Detailed Description	D 'Alembert advanced this idea as an extension to dynamics from statics. It has been extended by many authors. Bertalanffy extended the idea to open systems, which maintain equilibrium in the face of mass, energy and information flows across their boundaries
Inclusion Criteria	Does the system attempt to maintain equilibrium in the face of disruptions?
Exclusion Criteria	Not Required
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	The action of maintaining equilibrium requires operations of some sort
How is it related to the proposition?	
What features or principles are being drawn out?	
What specific details are being discussed?	The large variety of mechanisms/conversions that a system will develop and use to maintain equilibrium.
How does this translate to the competency framework?	Most systems will attempt to maintain equilibrium; some may have the concept of a trajectory that they want to be on (homeorhesis). What skills are required to accomplish that goal(s)
Does a different axiom or proposition also get referenced?	Homeostasis, homeorhesis, viability, suboptimization, self-organization
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	Bertalanffy was an early trigger for this research
Why did I include this document?	Core
Was there a surprise?	No
Did I see other areas to explore?	Yes

Is a new code or codes required?	No
Summary: Dynamic equilibrium is more expansive in the "open System" perspective than in the D'Almbert's exposition. Bertalanffy's perspective is more useful to the framework as it is more appropriate for an open system.	

(Aronowitz, 1981) (Ashmos & Huber, 1987) (Bailey, 1984) (Bertalanffy, 1951) (Colin & Crawford, 2000) (Forrest, 2004) (Forrest, 2006) (Fraser, 1985b) (Fraser, 1985a) (Fraser, 1990) (Jentoft, Son, & Bjørkan, 2007) (Johnson, et al., 1964) (Kast & Rosenzweig, 1972) (Levins, 1998) (Liu et al., 2007) (Maria & Dias, 1999) (Martin, 2001) (Meinig, 1979) (Nickerson & Zenger, 2002) (J. R. Thompson, Baggett, Wojciechowski, & Williams, 2006) (Troncale, 1978) (Young, 1970)

Axiom: Operational Proposition: Homeorhesis	
Short Description	The concept encompassing dynamical systems which return to a trajectory, as opposed to systems which return to a particular state, which is termed homeostasis.
Detailed Description	Not Required
Inclusion Criteria	Is the discussion about a dynamical or static system? Is there a disturbance that pushes it off the trajectory and does it return?
Exclusion Criteria	Static? No return, no flow?
Typical Exemplars	Fetal development, epigenetics
Atypical Exemplars	Criminal recidivism?
Close, but No	Not Required

How is the axiom being discussed?	Discussion of DNA as 'settled upon' as the unreactive memory, whilst RNA is the active decoder and creator of enzymes.
How is it related to the proposition?	Fundamental behavior of a system to achieve operationality
What features or principles are being drawn out?	The response of the system to external changes
What specific details are being discussed?	specific examples - antibody system development; London sparrows response to change from horse dung to autos
How does this translate to the competency framework?	Must there be a competency element that reflects the requirement to be able to respond to exogenous changes?
Does a different axiom or proposition also get referenced?	included relaxation time, hierarchy, feedback, complementarity and information theory
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Mostly visible
What did I learn from this document?	(Waddington, 1968)- included relaxation time, hierarchy, feedback, complementarity and information theory - The direct connections to other principles were exciting.
Why did I include this document?	Fundamental discussion of the concept of homeorhesis

Was there a surprise?	shortness of discussion
Did I see other areas to explore?	Note: HOMEORHESIS is not in either the OED or the Merriam Webster dictionary Yes - coupling with relaxation time. Concept of Dynamic equilibrium
Is a new code or codes required?	Yes - use current term
Summary: What trajectory is a system on? Does it get bumped off that trajectory and have the capability to return to the original? What if the new trajectory is better? Or faster to get to the goals?	

(Bauman & Currie, 1980) (Burgelman, 1983) (P. Corning, 2002) (T. A. Day, 2005) (Dubov, 2007) (Gruber, 1982) (Hahlweg, 1991) (Hall, 1992) (Heslop-Harrison, 1959) (Ho & Saunders, 1979) (S. Hoffmann, 1995) (Hyland, 2013) (Kilburg, 1976) (McEwen & Wingfield, 2010) (Patten, 2004) (Pearson & McLaren, 1977) (Sterling, 2004) (Sterling, 2012) (B. L. Thompson & Levitt, 2010) (Woodcock, 1978) (NOT Available - not used) (Waddington, 1977a) (Waddington, 1968) (Waddington, 1977b)

Axiom: Operational Proposition: Homeostasis	
Short Description	The property of an open system to regulate its internal environment so as to maintain a stable condition, by means of multiple dynamic equilibrium adjustments controlled by interrelated regulation mechanisms.
Detailed Description	
Inclusion Criteria	Does the system return to a prior equilibrium state after an external shock to the system?
Exclusion Criteria	If it follows a trajectory to a new stable state, this would be homeorhesis
Typical Exemplars	Living creatures, human systems
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	
How is it related to the proposition?	
What features or principles are being drawn out?	How does the system respond to the shock/stimulus? What mechanisms are available? Extended discussion of various cell parameters (O_2, sugars, carbohydrates, proteins) (W. Cannon, 1929)
What specific details are being discussed?	Cannon was focused on the cellular/organism with some extension beyond the living organism.
How does this translate to the competency framework?	The organization will have a wide variety of parameters to measure 'being in equilibrium'. Having a method to determine which are the correct ones, which ones actually cause conflict when trying to respond to a shock, and so on.
Does a different axiom or proposition also get referenced?	Yes
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	The detailed study by Cannon of the cell, with the extension to other organismic like systems
Why did I include this document?	Seminal article

Was there a surprise?	Desire to separate homeostasis from equilibrium
Did I see other areas to explore?	Many
Is a new code or codes required?	No
Summary: Homeostasis has served as a foundation for many human and social systems. It both helps and hurts (when they actually need to change but can't/don't) organizations.	

(Abel, 2009) (Ball, 1978) (W. Cannon, 1929) (W. B. Cannon, 1932) (Cariani, 2009) (Downing, 2012) (Houston, 1999) (Izquierdo, Harvey, & Beer, 2008) (McEwen & Wingfield, 2010) (McFarland-Wilson, 2010) (Montgomery, Hendricks, & Bradley, 2001) (Shrivastava, Sonpar, & Pazzaglia, 2009) (Sterling, 2004) (Sterling, 2012) (B. L. Thompson & Levitt, 2010) (Tolley, 1994) (Upton, 2011) (Valente, 2010) (Weinstein & Shuck, 2011) (Yolles, 2009)

Axiom: Operational Proposition: Redundancy	
Short Description	Means of increasing both the safety and reliability of systems by providing superfluous or excess resources.
Detailed Description	Consideration principle redundancy (use one more than one principle to provide redundancy), as well as redundancy of Parts and Redundancy of functions when discussing organizations (Pahl, et al., 2011)
Inclusion Criteria	Is there more than one 'thing' to provide the same function?
Exclusion Criteria	Is there a lack of overlap?
Typical Exemplars	Multiple engines, different safety mechanisms (valves and diaphragm),
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Continued operation of the system in the face if unreliable components is the goal
How is it related to the proposition?	
What features or principles are being drawn out?	Different perspectives - principles, parts, functions.
What specific details are being discussed?	See Pahl
How does this translate to the competency framework?	How does the organization deal with stress? what happens when someone is missing? or some piece of equipment?
Does a different axiom or proposition also get referenced?	RPC, Information Redundancy, feedback, recursion
Does the text indicate a missing axiom or proposition that should be added?	Temporal Aspects
Are the assumptions visible or are there hidden assumptions?	Assumptions not very obvious in Pahl
What did I learn from this document?	Principle Redundancy concept
Why did I include this document?	Seminal paper
Was there a surprise?	Principle Redundancy
Did I see other areas to explore?	No
Is a new code or codes required?	Temporal Aspects
Summary: Redundancy is required in the face of unreliability if the system is going to remain functioning. There is a tradeoff, since the redundant components may not provide value when the system is actually working without them in place of the primary components	

(Barnes, 1968) (Björk, 1975) (Müller, 1992) (Newig, Günther, & Pahl-Wostl, 2009) (Newig, Günther, & Pahl-Wostl, 2010) (Pahl-Wostl, 2009) (K. A. Richardson, 2004b, 2005b) (Streeter, 1992) (Ulanowicz, 2001) (Ulanowicz, 2003)

Axiom: Operational Proposition: Relaxation Time	
Short Description	"system stability is possible only if the system's relaxation time is shorter than the mean time (Skyttner)
Detailed Description	Stability near an equilibrium state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property. The system's equilibrium state is shorter than the mean time between disturbances.
Inclusion Criteria	Is there a return of the system to some equilibrium after the shock?
Exclusion Criteria	System does not return to equilibrium state
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	The proposition of relaxation time is a critical discriminator when making decisions about how to operate the system
How is it related to the proposition?	It is the proposition
What features or principles are being drawn out?	Control, Emergence
What specific details are being discussed?	How does the decision making affect the injection of shocks?
How does this translate to the competency framework?	An organization may need the capability to introduce shocks at time sequences longer than the relaxation time; otherwise the members go into chaos. This is only effective for endogenous impulses
Does a different axiom or proposition also get referenced?	Dynamic Equilibrium
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	How to consider relaxation time on a broader sense than previously thought of
Why did I include this document?	Seminal paper
Was there a surprise?	No
Did I see other areas to explore?	Yes
Is a new code or codes required?	No

Summary: Relaxation time might be an important idea when designing organizational changes. However, the flip side might also be examined: how does one reduce the Relaxation Time or make it very small so that continuous change can be accommodated? This would enable robustness against exogenous shocks.

(Batty, 1972) (Ceccatto & Huberman, 1989) (Chandler, et al., 1958) (Franksen, 1969a) (Franksen, 1969b) (Franksen, 1969c) (Gintis, 2007) (Grush, 2006) (Iberall & White, 1988) (Lin & Kahn, 1977) (Morse, 1955) (Rhoades, 1985) (K. A. Richardson, 2005b) (Whitt, 1983) (Yamamura & Tsuji, 1987)

Axiom: Operational Proposition: Self-organization	
Short Description	The spontaneous emergence of order out of the local interactions between initially independent components. (Ashby, 1947) Ashby actually wrote "a spontaneous change of organization will occur if one of the variables is a step-function of the time."
Detailed Description	Assumptions include: some, real material dynamic system which we can examine objectively, and whose variables can be specified numerically. The "Configuration" of the system is defined as the set of numbers which are the values of the variables. The "Behavior" of the system is specified by the successive configurations with the time-intervals between them. The system is subject to experimental control and knowledge of a configuration of the system is sufficient to specify its subsequent behavior. (Ashby, 1947)
Inclusion Criteria	If the system meets the above definition and assumptions it is self-organizing
Exclusion Criteria	Otherwise, it's not.
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Not
How is it related to the proposition?	It is the proposition
What features or principles are being drawn out?	For an absolute system, the relationship between the elements defines the ability to change when one element is changed.
What specific details are being discussed?	Not Required
How does this translate to the competency framework?	How does the organization take advantage of self-organization? How does the organization prevent self-organization from ripping it apart?
Does a different axiom or proposition also get referenced?	No
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Assumes an understanding of absolute systems
What did I learn from this document?	What Ashby said and what we said he said are two different things
Why did I include this document?	Seminal document

Was there a surprise?	The use of 'organizational closure'
Did I see other areas to explore?	The use of 'organizational closure'
Is a new code or codes required?	Maybe - see organizational closure
Summary: The tendency for self-organization to arise is not yet well understood, and thus is more controlled by pragmatic approaches. Some science is developing how to create conditions for self-organization that is favorable to the larger organization.	

(Abel, 2009) (Barrett, 2012) (Björk, 1975) (Espinosa, et al., 2007) (Houston, 1999) (R. Kay, 2002) (Kotter & Schlesinger, 1979) (Müller, 1997) (Pask, 1964) (Pask, 1981) (Phillips, 1999) (R. C. Richardson, 2001) (Rouse, 2003) (Sahal, 1979) (NOT Available - not used) (Sahal, 1983) (M. Shannon, 2002) (Snowden, 2005) (D. Swanson et al., 2010) (Swenson, 1997) (Swenson, 2000) (Turner, 2008) (Zexian, 2007) (Zimmerman & Hurst, 1993)

Axiom: Operational Proposition: Suboptimization	
Short Description	If each subsystem, regarded separately, is made to operate with maximum efficiency, the system as a whole will not operate with utmost efficiency. (Hitch, 1953)
Detailed Description	Not Required
Inclusion Criteria	Whenever a lower level hierarchical unit elects to develop and execute actions that improve its local performance, but there is degradation of the overall system performance. If the improvement is "approved" by higher levels but still degrades performance of the entire system, this is still Suboptimization.
Exclusion Criteria	Actions that improve the entire system performance.
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Suboptimization arose from an understanding of the operational effects.
How is it related to the proposition?	It is the proposition
What features or principles are being drawn out?	Relations between military operations and economics.
What specific details are being discussed?	How to express problems in terms of stating conceptual frameworks and then turning them into analysis. The use of requirements as an intervening model to try to get to the constraints.
How does this translate to the competency framework?	Organizations need to be able to use their resources (M5I) effectively to operate and be viable. Having skills to either prevent suboptimization (or to use it for advantage of the entire business) is a crucial competence
Does a different axiom or proposition also get referenced?	Control, hierarchy, PNF, viability
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Assumptions appear to be examined
What did I learn from this document?	Interesting discussion of pitfalls - authorititis, mechanitis. This is also a precursor for Ackoff concerns with OR

Why did I include this document?	Seminal
Was there a surprise?	The concept of the "second-best" as a better solution
Did I see other areas to explore?	Yes
Is a new code or codes required?	No
Summary: Hitch provides a detailed view of how to move forward to reduce suboptimization, but also how to improve decision-making in general.	

(Arthur, 1969) (Carroll, 1965) (Checkland, 1985) (Erström, 2010) (Georgantzas & Ritchie-Dunham, 2003) (Hellström, Lifvergren, & Quist, 2010) (Hitch, 1958) (Hoffman, 1959) (Jenkins, 1972) (Jönbrink et al., 2012) (Kirby, 2003) (Matthews, 2008) (Melese, 2009) (Melese, 2010) (M. J. Miller, Pulgar-Vidal, & Ferrin, 2002) (K. A. Richardson, 2005b) (Ridgway, 1956) (Thomas & Williams, 2009) (L. Williams & Thomas, 2009)

Axiom: Viability Proposition: Circular Causality	
Short Description	An effect becomes a causative factor for future effects, influencing them in a manner particularly subtle, variable, flexible, and of an endless number of possibilities. (Korzybski, 1958)
Detailed Description	TH E aspects of ecology to be considered regard primarily the study of the conditions under which groups of' organisms exist. Such groups may be acted upon by their environment, and they may react upon it. If a set of properties in either system changes in such a way that the action of the first system on the second changes, this may cause changes in properties of the second system which alter the mode of action of the second system on the first. Circular causal paths can be established in this manner. (Hutchinson, 1948)
Inclusion Criteria	Do the effects of one component change another that then reflects back to the original and so on? Are the loops longer? DO they have more than two components in the loop?
Exclusion Criteria	Cases where there is no apparent connection from the affected system back to the affecting system
Typical Exemplars	Hunter-prey populations;
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Circular causality may be required for system viability or it may threaten system viability. Understanding which condition obtains is necessary.
How is it related to the proposition?	Circular causality is the proposition.
What features or principles are being drawn out?	There are two perspectives: the first is the temporal relationship where something that happens now will affect another system component in the future and that component will in turn come back and affect the system component that started the circle. However, the starting point can be very hard to discern. The second prospective, has less temporal relationship, and is more related to the concept of feedback where there is an element of control.

What specific details are being discussed?	The temporal relationship was a focus of the early examination of circular causality. It drove much of the reason for the Macy conferences.
How does this translate to the competency framework?	With respect to competencies, the key is to first be able to recognize a circular causal chain, then to understand how to modify the chain whether it is a virtuous circle were vicious loop.
Does a different axiom or proposition also get referenced?	Feedback, control, temporal relationship, communication,
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Korzybski makes significant efforts to expose his assumptions and his logic...
What did I learn from this document?	The different perspectives of circular causality and potential different meanings imputed to the term.
Was there a surprise?	Yes. The topic of general semantics was new and worth exploring at a later time.
Did I see other areas to explore?	Gen. semantics
Is a new code or codes required?	No
Summary: circular causality is a key proposition when dealing with complex systems for system of systems. The numerous loops formed by interconnections, many of which are invisible, makes understanding the system a challenge. It is one of the reasons why experimenting is required to expose those hidden loops and relationships. Exposing those hidden relationships will hopefully reduce the probability of failure when attempting to improve the performance of a complex system.	

(Achinstein, 1962) (Achinstein, 1963) (Achinstein, 1990a) (Achinstein, 1990b) (Achinstein, 1992) (Achinstein, 1994) (Anglin, 1981) (Chapanis, 1951) (Cox, 1992) (Cronin, et al., 1991) (Dexter, 1939) (Foerster, 1981) (Granger, 1988) (Hayakawa, 1943) (S. H. Hodgson, 1879) (Hutchinson, 1948) (Jutoran, 1994) (J. Kay, 2011) (Gerald Midgley, 2003) (Montagnini, 2007) (Montagnini, 2008) (Markus Schwaninger, 2004) (Scott, 2004) (von Foerster, Mead, & Teuber, 1953)

Axiom: Viability Proposition: Feedback	
Short Description	All purposeful behavior may be considered to require negative feed-back. If a goal is to be attained, some signals from the goal are necessary at some time to direct the behavior.(Rosenblueth, et al., 1943)
Detailed Description	This control of the machine on the basis of its actual performance rather than its expected performance is known as feedback, involves sensory members who are actuated by motor members and perform the function of telltales or monitors – that is, of elements which indicated performance. It is a function of these mechanisms to control the mechanical tendency toward disorganization; in other words, to produce a temporary local reversal of the normal direction of entropy.(Wiener, 1988, pp. 24-25)
Inclusion Criteria	Is there a signal that is being used to modify the performance of the system? Does the signal come from or is it sensed by some component of the system? The feedback can either damp or excite system performance in which case is either negative or positive feedback.
Exclusion Criteria	Is there an open loop? Meaning either the system had no provision for the sensing routing or use of the signal based on its performance, or the signal path is somehow broken, attenuated, or has otherwise failed.
Typical Exemplars	Driving a car, steering an airplane or boat, all of which have a human in the loop providing feedback. Automatic systems can also provide feedback, so the car can be on cruise control or autopilot can be used for the airplane or boat. Similar concepts can be used in human activity systems.
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Viability implies the presence of a goal, which can only be reached by corrections between the current state and that goal state being made via the mechanism of feedback.
How is it related to the proposition?	Is the proposition
What features or principles are being drawn out?	Wiener, and others, described numerous examples of both negative and positive feedback. Initially the focus was on mechanical systems like anti-aircraft guns, and then expanded to a larger mechanical systems but the use of the proposition in human systems was unavoidable.

What specific details are being discussed?	
How does this translate to the competency framework?	In order for an organization to achieve its goals, and remain viable, its members must be able to discern the presence or lack of feedback in the systems within impacting the organization. They must also understand how to correct problems in feedback loops that are preventing the organization from achieving its goals.
Does a different axiom or proposition also get referenced?	Control, communication, leadership, temporal relationships
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Wiener does a very good job of describing his assumptions.
What did I learn from this document?	The very early and very rapid progression of the concept of feedback from a purely mechanical problem like antiaircraft gun control to the much broader use of using feedback in social systems.
Why did I include this document?	Seminal document
Was there a surprise?	The rapidity with which the idea spread and essentially became "common knowledge"
Did I see other areas to explore?	Yes
Is a new code or codes required?	No
Summary: feedback both negative and positive is required to exercise control of the system. Understanding the different forms of feedback and how to use feedback especially with the temporal relationships in human systems is a key element of the competency model framework.	

(Fenwick & De Cieri, 1996) (J. R. Freeman, 1983) (R. Freeman & Tryfonas, 2011) (Granger, 1969) (Granger, 1988) (G. Klein, B. Moon, & R.R. Hoffman, 2006) (G. Klein, B. Moon, & R. R. Hoffman, 2006) (Montagnini, 2007) (Montagnini, 2008) (Morrison, et al., 2008) (Wiener, 1948a) (Wiener, 1956) (Wiener, 1961) (Wiener, 1988)

Axiom: Viability Proposition: Recursion	
Short Description	The fundamental laws governing the processes at one level are also present at the next higher level.(Beer, 1979, p. 310)
Detailed Description	Any viable system contains and is contained in, a viable system. (Beer, 1979, p. 308) Recursion is process by which that seeks is found. (Beer, 1979)
Inclusion Criteria	Does the structure replicate?
Exclusion Criteria	Different structures used at different levels
Typical Exemplars	Sales organizations
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Directly relates recursion to viability
How is it related to the proposition?	It is
What features or principles are being drawn out?	The repeatability of the structure, whether it is a process or organization at different levels
What specific details are being discussed?	
How does this translate to the competency framework?	An organization needs to be able to replicate successful structures at different levels, as well as understand how to take advantage of recursion.
Does a different axiom or proposition also get referenced?	Control and Hierarchy
Does the text indicate a missing axiom or proposition that should be added?	No
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	The expansiveness of the concept - beyond structure of organization
Why did I include this document?	Seminal paper
Was there a surprise?	No
Did I see other areas to explore?	No
Is a new code or codes required?	No
Summary: Recursion allows an organization to replicate structure and this meaning across different levels. If one level is changed, how does the change get replicated (seems like a skill needed in many organizations)	

(Achterbergh & Vriens, 2002) (Michael A Arbib & Manes, 1974) (Beer, 1979) (Beer, 1972) (Fujigaki, 1998) (Harb, Zaher, & Zohdy, 2002) (Hornborg, 1998) (Keating, Fernandez, Jacobs, & Kauffmann, 2001) (Maturana, 1975) (Morin, 1992) (Rouse, 2007) (Markus Schwaninger & Ríos, 2008) (Tejeida-Padilla, Badillo-Piña, & Morales-Matamoros, 2010) (Tsuchiya, 2007)

Axiom: Viability Proposition: Requisite Hierarchy	
Short Description	The weaker in average are the regulatory abilities and the larger the uncertainties of available regulators, the more hierarchy is needed in the organization of regulation and control to attain the same result, if possible at all (Aulin-Ahmavaara, 1979)
Detailed Description	$$H(Y) = H_R(D) - K + I(Y,R)$$ $$= H(D) - I(D,R) - K + I(Y,R).$$
Inclusion Criteria	Does the organization measure its regulatory abilities? Does it even know how to do that? If it does measure, is its response to move regulatory capability to those areas that are weak?
Exclusion Criteria	Organizations that do not measure and then use the measure as part of the decision making on where to allocate regulatory resources
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Without regulation, the organization is not viable.
How is it related to the proposition?	It is
What features or principles are being drawn out?	Different cases are discussed, beginning with Ashby's homeostat, and moving to more general cases.
What specific details are being discussed?	The cases are extended to human survival
How does this translate to the competency framework?	An organization that cannot allocate appropriate regulation capability is doomed to non-viability
Does a different axiom or proposition also get referenced?	Control, hierarchy, emergence
Does the text indicate a missing axiom or proposition that should be added?	Maybe - Law of social hierarchy
Are the assumptions visible or are there hidden assumptions?	Generally visible
What did I learn from this document?	The potential for a classless society can be demonstrated theoretically, but it seems like friction will always get in the way

Why did I include this document?	Seminal
Was there a surprise?	No
Did I see other areas to explore?	No
Is a new code or codes required?	No
Summary: This proposition provides some guidance on how to actually allocate regulatory resources as well as how many resources might be required.	

(Aulin-Ahmavaara, 1985) (Aulin-Ahmavaara, 1986) (Aulin-Ahmavaara, 1987) (Brewis, 2004) (Colman, et al., 2005) (Gershenson, 2006) (Heylighen, 1999) (Järvinen, 2000) (Leonard, 2009) (K. A. Richardson, 2005b) (Stokes, 2004) (Stokes, 2006) (F. W. Taylor, 1914) (Troncale, 1988) (Varela, 1992)

Axiom: Viability Proposition: Requisite Variety	
Short Description	Control can be obtained only if the variety of the controller is at least as great as the variety of the situation to be controlled.(Ashby, 1956)
Detailed Description	This is a precursor to Requisite Hierarchy
Inclusion Criteria	How does one measure variety? Use this measurement to determine if the regulator is capable of managing the situation
Exclusion Criteria	If the organization does not measure variety, nor provide sufficiently capable controllers, it is not complying with the proposition
Typical Exemplars	Not Required
Atypical Exemplars	Not Required
Close, but No	Not Required

How is the axiom being discussed?	Control is required for viability
How is it related to the proposition?	Requisite Variety provide for viability to be possible.
What features or principles are being drawn out?	Extended discussion of how to determine RV and some discussion of allocation of RV resources.
What specific details are being discussed?	What are the requirements to be able to control an organization?
How does this translate to the competency framework?	Organizations must have the capability to regulate themselves in the face of both endogenous and exogenous changes.
Does a different axiom or proposition also get referenced?	Control, emergence, self organization
Does the text indicate a missing axiom or proposition that should be added?	Precursor to Requisite Hierarchy
Are the assumptions visible or are there hidden assumptions?	Visible
What did I learn from this document?	Relationships with control, emergence and hierarchy
Why did I include this document?	Seminal
Was there a surprise?	No
Did I see other areas to explore?	Yes
Is a new code or codes required?	No
Summary: Organizations must have the capability to regulate themselves in the face of both endogenous and exogenous changes. Understanding how to apply the proposition of Requisite Variety will endow an organization with those capabilities.	

(Ashby, 1962) (Ashby, 1958) (Bar-Yam, 2004) (Braun & Guston, 2003) (Daft & Wiginton, 1979) (De Vries, 2008) (De Vries, 2010) (F. Geyer, 1995) (F. Geyer & van der Zouwen, 1991) (Heylighen, 1997) (Mitroff & Emshoff, 1979) (Mitroff & Mason, 1983) (Pondy & Mitroff, 1979) (Markus Schwaninger, 1997) (Markus Schwaninger, 2001) (Stokes, 2004) (Stoyanov, Wischy, & Roller, 2005) (Troncale, 2011) (Zexian & Xuhui, 2010)

APPENDIX B EXPERT REVIEW OF LITERATURE DATA COLLECTION

The wide-ranging nature of systems theory requires the inclusion of scholarly literature from numerous fields including management, organizational design, hydrology, psychopathology, operations research, software design and development, and systems theory itself. The literature data search included databases with appropriate scholarly journals in the aforementioned fields.

The expert reviewers were provided with a number of questions to guide their review of the literature data collection. These questions were designed to elicit specific feedback on the scope and appropriateness of the literature data collected for the induction. The results of the expert review are presented on the following pages of this appendix. The Expert Review comment sheet is provided below:

The purpose of this section is to provide a simple and clear checklist for use in addressing the literature data collection. The results of this Expert Review will become data for the dissertation.

		Grading Selection				
Section: Research Design: Qualitative					EX	Provide reasoning and comments on grading
The use of qualitative research was the best fit for the problem		☐	☐	☐	☐	
The specific qualitative research technique used was appropriate to the problem		☐	☐	☐	☐	
	Grounded Theory					Provide reasoning and comments on grading
	The feature or characteristic of interest was identified	☐	☐	☐	☐	
	The study population possessed the feature or characteristic of interest	☐	☐	☐	☐	
	The methods of data collection were disclosed and were adequate	☐	☐	☐	☐	
	Additional Comments					
UN = Unacceptable, AD = Adequate, VG = Very Good, EX = Excellent						

Figure 23 and 24 report the actual comments provided by the expert reviewers.

The purpose of this section is to provide a simple and clear checklist for use in addressing the literature data collection. The results of this Expert Review will become data for the dissertation.

	Grading Selection				
Section: *Research Design: Qualitative*	UN	AD	VG	EX	Provide reasoning and comments on grading
The use of qualitative research was the best fit for the problem	☐	☐	☐	☑	
The specific qualitative research technique used was appropriate to the problem	☐	☐	☐	☑	See comments
Grounded Theory	UN	AD	VG	EX	Provide reasoning and comments on grading
The feature or characteristic of interest was identified	☐	☐	☐	☑	
The study population possessed the feature or characteristic of interest	☐	☐	☐	☑	
The methods of data collection were disclosed and were adequate	☐	☐	☐	☑	
Additional Comments					
(1)	Subquestion incomplete				
(2)	Additional source use recommended.				

Figure 27: Expert Reviewer 1 Comments

	Grading Selection				
Section: *Research Design: Qualitative*	UN	AD	VG	EX	Provide reasoning and comments on grading
The use of qualitative research was the best fit for the problem	☐	☐	☒	☒	I see no other way to develop a framework for competency models that to use qualitative research.
The specific qualitative research technique used was appropriate to the problem	☐	☐	☐	☒	The chosen approach was quite appropriate. Use of Discover's Induction to boot was particularly relevant as the author is not an impartial observer, given that he is a co-author on the seminal document used to identify the principles explored during the coding process.
Grounded Theory	UN	AD	VG	EX	Provide reasoning and comments on grading
The feature or characteristic of interest was identified	☒	☐	☒	☐	While I have no doubt that the coding will complete in earnest, the product as I reviewed it was a work in progress and thus my grade incorporates appreciation for work yet-to-be-complete.
The study population possessed the feature or characteristic of interest	☒	☐	☐	☒	I believe the references used for the coding were appropriate and necessarily exhaustive.
The methods of data collection were disclosed and were adequate	☒	☐	☐	☒	
Additional Comments					
The following comments are specific observations regarding coding results: -inclusion and exclusion criteria for emergence are identical, consider rewording to explain rationale -inclusion criteria for complementarity do not make sense -incompressibility, as you describe it in the darkness coding, seems to evoke more of minimum critical specification than darkness -you're missing your references for the holism coding in the code sheet					

Figure 28: Expert Reviewer 2 Comments

APPENDIX C SYSTEMS THEORY FRAMEWORK ELEMENTS

In Chapter 4, a small portion of the competency model framework was presented in systems theory terms. The complete selection is presented, fully annotated as to source here in Appendix B. The terms are organization by cell from each intersection of the first three categories, with each of the 9 propositions retained in the framework. Many of the remaining 21 propositions are referenced indirectly in these data elements.

Intersection of Control and Temporal Relationships

Time lags are most restrictive at low frequencies.(Chandler, et al., 1958)

Able to change goals. (Achterbergh & Vriens, 2002)

Understand patterns over time. (Morrison, et al., 2008)

Prediction => Control => rewards. (K. A. Richardson & Tait, 2010)

Observer cannot see system and what system sees. (Marken, 1990)

Elements at one location have significant time-space effects elsewhere through multiple connections and trajectories. (Urry, 2005, p. 238)

All self-organizing systems become informed of their world or perish.(Scott, 2004, p. 1367)

Intersection of Equifinality and Temporal Relationships

Closed Systems become stationary when time variations disappear; open systems can get to the stationary state by maintaining a continuous flow of matter and energy. (Bertalanffy, 1950b)

Which system part is dominant? This affects the decisions that are made. (Doty, et al., 1993)

Large lag effects require system designers to allow their changes to permeate through the system. (Doty, et al., 1993)

Understand the content of historical studies to determine how broadly it can be generalized.(D. Miller, 1981)

Suboptimal equifinality reduces managerial discretion. (G. T. Payne, 2006)

Traditional bivariate views are contraindicated by equifinality. (G. T. Payne, 2006)

Intersection of Purposive Behavior and Temporal Relationships

Purposive behavior must have a time element to be relevant.(Churchman & Ackoff, 1950)

On purpose does not mean consciously. Hierarchy enables complexity without consciousness. (Marken, 1990)

Many interventions are one-shot processes. Consider the temporal aspects of interventions.(K. A. Richardson & Tait, 2010)

The human systems lack defined boundaries. Considering time allows definition of dynamical adjustments and effects. (Srinivasan, 1974)

Goals can be defined in terms of some degree of improvement rather than a specific state.(Srinivasan, 1974)
Connect purposeful actions to their outcomes by logic.(Susman & Evered, 1978)

Intersection of Satisficing and Temporal Relationships
The ability to determine problems that require a solution and those that lead to learning which will result in an improvement of the situation. Otherwise, you will be trapped by clashes over norms, values and Weltanshauungen.(Checkland, 1985, p. 765)
Strategy is a satisficing process of managing changing needs and interests over time. (Habbershon, et al., 2003)
Real-world decision tasks are often characterized by ill structured problems, dynamic environments or conflicting goals which makes it hard to find the optimum solution. (Louvieris, et al., 2010, p. 3231)
The only scarce resource is time.(Simon, 1956, p. 136)

Intersection of Dynamic Equilibrium and Temporal Relationships
Distinguish when to use an approach that defines the processes as a succession of macroscopic equilibrium states which do not depend, per se, on time. (Franksen, 1969c, p. 70)
Another approach is to deal directly with "disorder, instability, nonlinear relationships between open systems, morphogenesis and temporality." (F. Geyer, 1995, p. 24)
Four sequences:" Disequilibrium, Amplifying Actions, Recombination/Self Organization and stabilizing feedback are necessary but not sufficient for newly emergent order." (Lichtenstein & Plowman, 2009, p. 626)

Intersection of Relaxation Time and Temporal Relationships
Include relaxation time when considering complicated tradeoffs and resource utilization problems.(Ceccatto & Huberman, 1989)
Change will not only occur when the system is in equilibrium. (Franksen, 1969a, p. 302)
Relaxation time depends on the system being considered. (Iberall & White, 1988)
Systems will return to their long run state after moderate shocks, but efficiency is impaired. (Gintis, 2007)
Large shocks are restored more slowly. (Gintis, 2007)
Relaxation time of one system is impacted by that of other systems.(Yamamura & Tsuji, 1987)
The most restrictive condition on time lags and relaxation time is at low frequencies. (Chandler, et al., 1958)
Intersection of Self Organization and Temporal Relationships
"Complex systems typically have a nested hierarchical structure, with interactions across the levels. There is a mix of fast and slow processes, time lags play a critical role. " (De Vries, 2010, p. 150)
"Processes may be serial or parallel, synchronous or asynchronous. All controlled

process are subject to the law of requisite variety."(Scott, 2004, p. 1367)
Proximity is a driver for interaction (D. Swanson, et al., 2010).

Intersection of Feedback and Temporal Relationships
Improved meaning making increases effectiveness. (Barrett, 2012)
Feedback loops may include self-defeating mechanisms which lower predictive accuracy over time rather than increase it.(F. Geyer & van der Zouwen, 1991, p. 88)
"Such negative or self-defeating mechanism exist in only the social world." (F. Geyer & van der Zouwen, 1991, p. 88)
"Negative feedback loops have a spatio-temporal boundary setting function." (Mitterauer & Kopp, 2003, p. 358)
A model's usefulness lies in its ability to simplify the system to permit greater comprehensibility. (Morrison, et al., 2008)
"The feedback lens enriches understanding of the situation." (Morrison, et al., 2008, p. 27)
Intersection of Requisite Variety and Temporal Relationships
A system must continuously develop in order to maintain its fitness relative to the system it coevolves with. (Heylighen, 1999, p. 30)
The information explosion is the result of that continuous development. (Heylighen, 1999)
Some systems stop evolving when they reach a good tradeoff point and are not confronted by a more demanding environment .(Heylighen, 1999)

Intersection of Control and Leadership
Translate goals of the organization to the goals of the function. (Achterbergh & Vriens, 2002)
When setup properly all levels of the hierarchy can meet their purpose nearly simultaneously. (Marken, 1990)
Existence requires control.(Achterbergh & Vriens, 2002)
Setting targets and monitoring whether these goals are met.(Achterbergh & Vriens, 2002)
Deals with ambiguity. (Beven, 2006)
Capable of adapting to change. (Cherns, 1976)
Conflict arises when one control system can only achieve its goal by acting in a way that moves another control system away from its goal. (Marken, 1990)
Intersection of Equifinality and Leadership
Non-uniqueness is often viewed as a difficulty vice an intrinsic characteristic.(Beven, 2006)
There is an implicit assumption that there is only one way to succeed. (D. Miller, 1981)
A very slight change in the character of a response may destroy the adaptedness to one solution and suit it entirely for another one. (By extension, this speaks to high nonlinearity affecting final results from seemingly trivial differences at start).(Sumner, 1910)

Intersection of Purposive Behavior and Leadership

[Purposive behavior] requires "communication concerning communicatively constructed knowledge about both primary processes and goals, gaps, causes and actions." (Achterbergh & Vriens, 2002, p. 230)

Insight permits distinctions so correct course of action is chosen from choices like structure changes, communication system changes or HRM action is required. (Achterbergh & Vriens, 2002)

Mapping problematique before moving to design alternatives answers question "Where is the proper starting point?" (Broome & Keever, 1989)

Purpose must be clear to prevent internal definitions being defined by aims of the formulators. (Churchman & Ackoff, 1950)

Intersection of Satisficing and Leadership

"At levels above the operational, consensus breaks down." (Checkland, 1985, p. 765)

"Connections are direct as logical and physical paths or indirect based on influence and such as how politician relate to the their constituency." (DiMario, et al., 2009, p. 361)

Satisficing allows for degrees of fulfillment, rather than an absolute success or failure. (DiMario, et al., 2009, p. 361)

"Enable parts and the containing system to do things that they could not otherwise do." (Habbershon, et al., 2003, p. 456)

Prediction is the essence of design. (Hollnagel, 2000)

Precision and details serve to identify the required requisite variety. (Hollnagel, 2000)

Goal formation; Searching; Expectation; Evaluation; Selection. (Matsuda & Takatsu, 1979)

Intersection of Dynamic Equilibrium and Leadership

Take advantage of random fluctuations to jump to a new Basin of Stability. (Lin & Kahn, 1977)

Crossovers, when they occur, happen really fast and the system is often constrained from responding thus it needs coordinating agents to do so. (Ceccatto & Huberman, 1989)

It is difficult to find appropriate measures which, in effect, average the parameters of the system over its past – which makes forecasting really hard. (Batty, 1972)

Intersection of Relaxation Time and Leadership

Relaxation times can be difficult to ascertain. (Batty, 1972)

Ensure that the model for relaxation time is built from a dynamic perspective. (Batty, 1972)

Systems display behavior over time as well as space. (Batty, 1972, p. 172)

Sudden change in the nature of a network in which an open system is embedded is an interesting problem. "If the system is adaptable, one would expect it to move to a new optimal strategy mix over time." (Ceccatto & Huberman, 1989, p. 3443)

Newness will require some time to correlate response, with instability giving rise

to new assemblies. (Grush, 2006)

Intersection of Self Organization and Leadership

An adaptive self-regulating system must include redundancy in the design, or else it will be adaptive to only a finite, strictly identified set of environmental conditions. (Björk, 1975)

Consider the reciprocal influence process between leaders and followers. (Kan & Parry, 2004)

A range of problem solving approaches will enable adapting one to suit the problem. (R. Kay, 2002)

Enable the organization to partially determine its own design and thus remain responsive to unexpected situations. (Mulvihill & Keith, 1989)

Any deficiencies in an organization impair the viability. (Markus Schwaninger, 2004)

Intersection of Feedback and Leadership

Feedback, especially nonlinear feedback, is critical to emergence, self-organization, adaptation, and learning. (Yorks, 2013, p. 7)

"Integrated performance management system must: link corporate strategy to vision of the organization's objectives; set individual performance goals with their involvement in context of position and organization; provide regular feedback; provide means for improving performance and demonstrate link between results and rewards." (Fenwick & De Cieri, 1996, p. 78)

Direct feedback at work related behavior not the person. (Fenwick & De Cieri, 1996)

Intersection of Requisite Variety and Leadership

Division can reduce conflict which will maximize velocity (rate of change). (Prokopenko, et al., 2009)

Evolve from one man/one job to self-maintaining socio technical units with emphasis on necessary roles. (Robinson, 1982)

An outcome of RV is that "there will be unexpected uses for the system, unexpected behavior and 'unknown' problems to solve." (Siemieniuch & Sinclair, 2006, p. 104)

Intersection of Control and Performance

It is the purpose of control function to ensure synergy of the function ones. (Achterbergh & Vriens, 2002)

Setting targets and monitoring. (Achterbergh & Vriens, 2002)

Learning (workforce knowledge) is required to be updated. (Achterbergh & Vriens, 2002)

Using a static model is inconsistent with the world. (Batty, 1972)

System design must include self-modification to use creative capacities. (Cherns, 1976)

Systems view is required to focus on cost of control. (Jenkins, 1972)

Minimizing conflict will maximize results. (Marken, 1990)
Two types of control: autopoieitic and executive are required.(Stokes, 2004)
Intersection of Equifinality and Performance
The information content available to define a modeling problem will block/reduce the ability to produce a single model or unambiguous model. (Beven, 2006)
Organizational models can (should) be tested to validate them. (Doty, et al., 1993)
Suboptimal equifinality will introduce constraints that will restrict organizational design options. (G. T. Payne, 2006)
Managers will tend to pick one function to maximize performance, ignoring others that may produce better performance by balancing functions. (G. T. Payne, 2006)
Inference from averages to the particular case is impossible. (Richters, 1997)

Intersection of Purposive Behavior and Performance
One must know the proper starting point for an investigation. (Broome & Keever, 1989)
Prevent contamination of the group's ability to propose alternatives by recognizing the members' ideas and evaluations. (Broome & Keever, 1989)
Requires skill in formal operations. (Hogan, 2006)
"Executive control involves the ability to manage one's thoughts, memories and actions in accordance with task relevant goals." (Hogan, 2006, p. 208)
"Models ...1) failed to incorporate individual into organization 2) did not represent hierarchy of control systems 3) relied too heavily on espoused theories vice theories in use." (Vancouver, 1996, pp. 173-175)

Intersection of Satisficing and Performance
"Optimized systems are inflexible, as their interfaces to other systems have fixed boundaries and tight coupling." (DiMario, et al., 2009, p. 361)
Satisficing enables dynamics boundaries and loose coupling. (DiMario, et al., 2009)
"Satisficing replaces individual interests for group interests." (DiMario, et al., 2009, p. 363)
Managers tend to focus on one function resulting in suboptimal performance. (G. T. Payne, 2006)
Knowing how to decide is more important than knowing what to decide. (Simon, 1979) (implication is that how enables what, but what does not enable how).
Elaborate organizations arise to answer difficult questions. (Simon, 1979)

Intersection of Dynamic Equilibrium and Performance
Using static models for forecast dynamic behavior implies a basic inconsistency. (Batty, 1972)
Design (or redesign) of the holistic system requires management of the

constituent systems. (DiMario, et al., 2009)
"A fundamental basis of decision theory is that a system is rational if and only if it chooses actions that yield the highest utility. Group social functions are not a logical consequence of rational systems based on self-interest." (DiMario, et al., 2009, p. 361)
Failure to design systems for continual self-modification results in instability.(Keating, Kauffmann, et al., 2001)

Intersection of Relaxation Time and Performance
Systems display behavior over time as well as space. (Batty, 1972, p. 172)
The most restrictive condition on time lags and relaxation time is at low frequencies. (Chandler, et al., 1958)
Different scales evoke different responses to signals. (Grush, 2006)
The transient behavior contributes to the costs and benefits of operating the system. (Whitt, 1983)
"Different behaviors lead to different structures." (Batty, 1972)
A new strategy mix may increase the performance in the solution of the problem. (Ceccatto & Huberman, 1989)

Intersection of Self Organization and Performance
"Unpredictable emergent behaviors may give rise to whole courses of collective action being rather different than expected." (Rouse, 2003, p. 155)
"Viability, cohesion and self-organization rely on" recursion "at all levels in an organization." (Markus Schwaninger, 2004, p. 414)
Policies must not undermine existing social capital. (D. Swanson, et al., 2010)
Create and promote effective spaces and issues for adaptive cooperation. (D. Swanson, et al., 2010, p. 933)
Improvements take many forms. Adaptive organizations revise failing policies in light of new conditions. (D. Swanson, et al., 2010)
Copying is an effective strategy to disseminate new techniques. (D. Swanson, et al., 2010)

Intersection of Feedback and Performance
Meaning making affects results. Thinking more strategically, collaborating more, seeking out feedback, resolving conflicts better, making greater efforts to develop subordinates and redefining challenges to capitalize on cross connections are all hallmarks of higher performance. (Barrett, 2012)
Designs evolve, responding to direct feedback, as well as sensing environment changes. (Barrett, 2012)
Use probe and testing, modify leadership role and perspective as context shifts. (Barrett, 2012)
Distinguishes between controllable and non-controllable variables. (Markus Schwaninger, 2004)

Intersection of Requisite Variety and Performance

The capacity may be bounded which will limit can be achieved. The regulator should thus get as close as possible to maximum and recognize no further (with that system design). (Ashby, 1956)

As complexity grows the toolset needs to expand. Some recommendations include: cognitive style analysis; stakeholder analysis, and so on. (Mitroff & Mason, 1983)

APPENDIX D CASE STUDY PROPOSITIONS

The purpose of this Appendix is to provide a structured approach to the review of the case study competency model. Each of the three major themes: Temporal Relationships, Leadership and Performance are intersected with the 4 themes of Centrality, Goal, Operation and Viability of the Competency Model Framework. The grading follows a scale developed by a working group in an unpublished report in the summer of 2011. The grades are: Unacceptable (UN), Adequate (AD), VG (very Good) and Excellent (EX). Descriptions of the grades are as follows:

- Unacceptable: Not present, or so poorly described as to be unexecutable by the most skilled individuals;

- Adequate: Meets minimum standards, is clear enough to be executed, but has gaps or missing elements;

- Very Good: Is well above standards, with sufficient detail to guide the person tasked to execute, with one or few missing elements;

- Excellent: Is the highest standard, with clear details meeting all the requirements of Minimum Critical Specification, and no missing elements.

	Grading Selection				
Section: Temporal Relationship	UN	AD	VG	EX	Grade Reasoning and Comments
Equifinality: Understands the hidden and delayed system responses that only become visible through time. Uses understanding of time in selecting which of many pathways is more likely to result in reaching the desired organizational goals.	☐	☐	☐	☐	
Purposive Behavior: Purposefully combines principles of time, consciousness, boundaries and goals to logically connect them into actions that, over time, allow or enable the organization to meet its goals.	☐	☐	☐	☐	
Satisficing: Recognizes time is the only scarce resource. Builds or uses satisficing processes, when appropriate, to manage changing needs and interests. Makes timely responses to ill structured, dynamic environments or conflicting goals rather than searching for an optimal solution.	☐	☐	☐	☐	
Dynamic Equilibrium: Rather than using approaches that define the processes as successive macroscopic equilibrium states which do not depend on time, is able to deal directly with disorder, instability, nonlinear relationships between open systems, evolution and temporal relationships. Uses approaches that include disequilibrium, amplifying action, recombination and stabilizing feedback as part of the necessary suite of processes for newly emergent order	☐	☐	☐	☐	

	Grading Selection				
Section: Temporal Relationship	UN	AD	VG	EX	Grade Reasoning and Comments
Relaxation Time: Understands system responses to shocks, how to consider relaxation time when implementing change and does not ignore relaxation time when considering complicated trade-offs in resource utilization. -Understands and uses differences in relaxation times between systems to the advantage of the organization.	☐	☐	☐	☐	
Self Organization: Understands the value of proximity to drive interaction within the commonly found nested hierarchical structures. Uses this understanding to drive interactions on multiple timescales, in parallel and series, synchronous or asynchronously with the goal of establishing the requisite variety for the organization to achieve its goals.	☐	☐	☐	☐	
Feedback: Uses feedback lens to enrich the understanding of the situation, while also recognizing that feedback can help or hinder by setting boundaries. Self-defeating feedback loops identified and mitigated by improving meaning making	☐	☐	☐	☐	
Requisite Variety: Understands how requisite variety enables a system to continuously develop as the environment also develops. Able to take advantage of or use the information explosion that results from continuous development.					

	Grading Selection				
Section: Temporal Relationship	UN	AD	VG	EX	Grade Reasoning and Comments
Control: Has a deep understanding of the organization and its environment that enables the use of time and control functions to predict performance, use system understanding to create, and revise goals to improve organization performance. Understands patterns as well as the world around the organization and the impact of those patterns on the organization.					

	Grading Selection				
Section: Leadership	UN	AD	VG	EX	Grade Reasoning and Comments
Equifinality: Understands and uses the opportunities presented by multiple paths to the same end state for organizational advantage, while recognizing the small changes that can result in dramatically different outcomes. Capable of recognizing these small changes in modifying the organization and its actions to prevent being undone by those seemingly small factors.	☐	☐	☐	☐	
Purposive Behavior: Able to communicate concerning communicatively constructed knowledge to impact primary processes and goals, gaps, causes, and actions. Uses leadership skills to control internal definitions and map the problematique before moving to design alternatives.	☐	☐	☐	☐	
Satisficing: Uses satisficing to achieve degrees of fulfillment rather than striving for absolute success or failure. Facilitates the organization to do things that they could not otherwise do, and recognizes that connections may be direct, but just as likely to be indirect, but that precision will allow identification of the required requisite variety.	☐	☐	☐	☐	
Dynamic Equilibrium: Recognizes and takes advantage of crossovers, despite their speed of occurrence, and coordinates the organization getting to a new (and better) basin of stability. Resists the tendency to use averages when specifics are needed to predict future performance.	☐	☐	☐	☐	

	Grading Selection				
Section: Leadership	UN	AD	VG	EX	Grade Reasoning and Comments
Relaxation Time: Knows how to respond to newness and adopt organization to new assemblies in the face of instability, despite the inherent difficulty of determining relaxation time in a complex system with multiple exogenous sources of change. Able to respond differently over time as the organization changes and is changed.	☐	☐	☐	☐	
Self Organization: Designs the organization to reduce deficiencies that impair viability, includes redundancy to provide adaptability, all with the minimum specifications to allow the freedom to find the needed paths to organizational goals. Recognizes that leadership is affected by followers rather than existing in isolation.	☐	☐	☐	☐	
Feedback: Able to use feedback, especially nonlinear feedback, to support emergence, self organization, adaptation and learning. When placed within an integrated performance measurement system, the corporate strategy is linked to the objectives, and individual goals are aligned to this context with regular feedback on progress, with needs for improving the performance linked to rewards based on results.	☐	☐	☐	☐	

	Grading Selection				
Section: Leadership	UN	AD	VG	EX	Grade Reasoning and Comments
Requisite Variety: Understands requisite variety allows and takes advantage of unexpected use of the system, unexpected behaviors, and responding to previously unknown problems to solve. Fosters socio-technical perspective rather than a one-man/one job perspective to enable necessary roles to be filled.	☐	☐	☐	☐	
Control: Has the ability to set organization goals, translate the organizational goals to function goals, and constructs to enable hierarchical levels to meet their goals nearly simultaneously. Establishes these goals so as to reduce internal conflicts while dealing with ambiguity and change in the organization and its environment.	☐	☐	☐	☐	

	Grading Selection				
Section: Performance	UN	AD	VG	EX	Grade Reasoning and Comments
Equifinality: Understands how ambiguity will drive many managers to pick a single idea, a single function, or a single solution to the detriment of the organization. Is able to deal with that ambiguity both on a personal and organization level to prevent being limited by the choice of one.	☐	☐	☐	☐	
Purposive Behavior: Using skills in formal operations, selects or guides the proper starting point for investigation. Uses knowledge of mental models to overcome flaws including: 1) not incorporating individual into the organization; 2) not representing the hierarchy of control; 3) relying on espoused theories vice recognizing theories in use.	☐	☐	☐	☐	
Satisficing: Understands that optimized organizations are inflexible, whereas satisficing enables dynamic boundaries and loose coupling. Knows how to decide and does so well.	☐	☐	☐	☐	
Dynamic Equilibrium: Designs the system for continual self modification in the face of instability by holistically managing the constituent systems by using dynamic models.	☐	☐	☐	☐	
Relaxation Time: Understands that transients impose costs on the organization. Understands the transients will have different effects at different scales, and different responses at different scales, and is able use the differences to the organizations benefit (or reduce/mitigate).	☐	☐	☐	☐	

	Grading Selection				
Section: Performance	UN	AD	VG	EX	Grade Reasoning and Comments
Self Organization: Understands social capital must not be undermined by crippling policies, but enabled by the creation and fostering of effective spaces for adaptive cooperation. These spaces must exist recursively at all levels in the organization and allow unpredictable emergent behaviors that give rise to courses of action that are different than expected.	☐	☐	☐	☐	
Feedback: Develops both autopoieitic and executive controls to set targets and monitor performance and causes action to close gap between performance and goal. Uses, improves, expands workforce knowledge to achieve desired organization results.	☐	☐	☐	☐	
Requisite Variety: Enables meaning making to get more strategic thinking, collaboration, feedback, better conflict resolution, better subordinate development while redefining challenges to get higher performance with designs evolved in response to feedback.	☐	☐	☐	☐	
Control: Able to discern the boundary or limit to performance with current system and only expends the resources needed to approach that limit. Seeks out different tools/ideas/skills to jump system to a higher region with expanded limits.	☐	☐	☐	☐	

APPENDIX E CASE STUDY RESULTS

The purpose of this Appendix is to provide a structured approach to the review of the case study competency model. Each of the three major themes: Temporal Relationships, Leadership and Performance is intersected with the 4 themes of Centrality, Goal, Operation and Viability of the Competency Model Framework. The grading follows a scale developed by a working group in an unpublished report in the summer of 2011. The grades are: Unacceptable (UN), Adequate (AD), VG (very Good) and Excellent (EX). Descriptions of the grades are as follows:

- Unacceptable: Not present, or so poorly described as to be unexecutable by the most skilled individuals;

- Adequate: Meets minimum standards, is clear enough to be executed, but has gaps or missing elements;

- Very Good: Is well above standards, with sufficient detail to guide the person tasked to execute, with one or few missing elements;

- Excellent: Is the highest standard, with clear details meeting all the requirements of Minimum Critical Specification, and no missing elements.

Theoretical sensitivity enters the analysis as the researcher wants to be able to identify a framework element, even if the organization does not use the terminology of the framework, yet also want to prevent imposing the researcher's perspective on the organization when the concept is not present. A discussion of this concern is contained in Chapter 5.

	Grading Selection				
Section: Temporal Relationship	UN	AD	VG	EX	Grade Reasoning and Comments
Equifinality: Understands the hidden and delayed system responses that only become visible through time. Uses understanding of time in selecting which of many pathways is more likely to result in reaching the desired organizational goals.	☐	☒	☐	☐	A2 – Model discusses developing, and executing a plan while leveraging skill sets but does not discuss selection of paths nor time.
Purposive Behavior: Purposefully combines principles of time, consciousness, boundaries and goals to logically connect them into actions that, over time, allow or enable the organization to meet its goals.	☐	☐	☐	☒	C1 – Addresses nearly all components in organization's terms of this element.
Satisficing: Recognizes time is the only scarce resource. Builds or uses satisficing processes, when appropriate, to manage changing needs and interests. Makes timely responses to ill structured, dynamic environments or conflicting goals rather than searching for an optimal solution.	☐	☐	☒	☐	C1 – Addresses most components in organization's terms of this element. Does not explicitly focus on using scarce resources.
Dynamic Equilibrium: Rather than using approaches that define the processes as successive macroscopic equilibrium states which do not depend on time, is able to deal directly with disorder, instability, nonlinear relationships between open systems, evolution and temporal relationships. Uses approaches that include disequilibrium, amplifying action, recombination and stabilizing feedback as part of the necessary suite of processes for newly emergent order.	☒	☐	☐	☐	Not covered on organization's competency model.

	Grading Selection				
Section: Temporal Relationship	UN	AD	VG	EX	Grade Reasoning and Comments
Relaxation Time: Understands system responses to shocks, how to consider relaxation time when implementing change and does not ignore relaxation time when considering complicated trade-offs in resource utilization. -Understands and uses differences in relaxation times between systems to the advantage of the organization.	☒	☐	☐	☐	Not covered on organization's competency model.
Self Organization: Understands the value of proximity to drive interaction within the commonly found nested hierarchical structures. Uses this understanding to drive interactions on multiple timescales, in parallel and series, synchronous or asynchronously with the goal of establishing the requisite variety for the organization to achieve its goals.	☐	☒	☐	☐	B1 – Minimal coverage of concepts of self-organization, and not in ST terms.
Feedback: Uses feedback lens to enrich the understanding of the situation, while also recognizing that feedback can help or hinder by setting boundaries. Self-defeating feedback loops identified and mitigated by improving meaning making	☐	☒	☐	☐	B9 – feedback is implied in language covering assessment of others' development.
Requisite Variety: Understands how requisite variety enables a system to continuously develop as the environment also develops. Able to take advantage of or use the information explosion that results from continuous development.	☐	☒	☐	☐	A3 – Personal mastery is interpreted to include requisite variety.

	Grading Selection				
Section: Temporal Relationship	UN	AD	VG	EX	Grade Reasoning and Comments
Control: Has a deep understanding of the organization and its environment that enables the use of time and control functions to predict performance, use system understanding to create, and revise goals to improve organization performance. Understands patterns as well as the world around the organization and the impact of those patterns on the organization.	☐	☐	☐	☒	C4, C5, B10 – Excellent coverage of this topic spread across different CM elements

	Grading Selection				
Section: Leadership	UN	AD	VG	EX	Grade Reasoning and Comments
Equifinality: Understands and uses the opportunities presented by multiple paths to the same end state for organizational advantage, while recognizing the small changes that can result in dramatically different outcomes. Capable of recognizing these small changes in modifying the organization and its actions to prevent being undone by those seemingly small factors.	☐	☒	☐	☐	A2 – Model discusses developing, and executing a plan while leveraging skill sets but does not discuss selection of paths nor time.
Purposive Behavior: Able to communicate concerning communicatively constructed knowledge to impact primary processes and goals, gaps, causes, and actions. Uses leadership skills to control internal definitions and map the problematique before moving to design alternatives.	☐	☐	☐	☒	A1, C3, C4 – Coverage across several elements of Competency Model.
Satisficing: Uses satisficing to achieve degrees of fulfillment rather than striving for absolute success or failure. Facilitates the organization to do things that they could not otherwise do, and recognizes that connections may be direct, but just as likely to be indirect, but that precision will allow identification of the required requisite variety.	☐	☒	☐	☐	B5, B6 – partial coverage, lacking satisficing element.
Dynamic Equilibrium: Recognizes and takes advantage of crossovers, despite their speed of occurrence, and coordinates the organization getting to a new (and better) basin of stability. Resists the tendency to use averages when specifics are needed to predict future performance.	☐	☐	☒	☐	C2, C3 – lacking understanding of averages compared to specifics.

	Grading Selection				
Section: Leadership	UN	AD	VG	EX	Grade Reasoning and Comments
Relaxation Time: Knows how to respond to newness and adopt organization to new assemblies in the face of instability, despite the inherent difficulty of determining relaxation time in a complex system with multiple exogenous sources of change. Able to respond differently over time as the organization changes and is changed.	☐	☐	☐	☒	B3, B10, C3 – Coverage is provided across the CM
Self Organization: Designs the organization to reduce deficiencies that impair viability, includes redundancy to provide adaptability, all with the minimum specifications to allow the freedom to find the needed paths to organizational goals. Recognizes that leadership is affected by followers rather than existing in isolation.	☐	☐	☒	☐	B1, B7 – Combines two elements that appear to invoke this self-organization features. Redundancy is lacking.
Feedback: Able to use feedback, especially nonlinear feedback, to support emergence, self organization, adaptation and learning. When placed within an integrated performance measurement system, the corporate strategy is linked to the objectives, and individual goals are aligned to this context with regular feedback on progress, with needs for improving the performance linked to rewards based on results.	☐	☒	☐	☐	B9, B11 – Partial discussion of Others' development level implies feedback. No discussion of measurement system.

	Grading Selection				
Section: Leadership	UN	AD	VG	EX	Grade Reasoning and Comments
Requisite Variety: Understands requisite variety allows and takes advantage of unexpected use of the system, unexpected behaviors, and responding to previously unknown problems to solve. Fosters socio-technical perspective rather than a one-man/one job perspective to enable necessary roles to be filled.	☐	☐	☒	☐	B7 – Invokes the word empowered, and uses the term releases, implying people are enabled to experiment. Lack discussion of socio-technical perspective.
Control: Has the ability to set organization goals, translate the organizational goals to function goals, and constructs to enable hierarchical levels to meet their goals nearly simultaneously. Establishes these goals so as to reduce internal conflicts while dealing with ambiguity and change in the organization and its environment.	☐	☐	☒	☐	C5 – Partial coverage. Conflict reduction between goals is not specifically identified in the organization's CM

	Grading Selection				
Section: Performance	UN	AD	VG	EX	Grade Reasoning and Comments
Equifinality: Understands how ambiguity will drive many managers to pick a single idea, a single function, or a single solution to the detriment of the organization. Is able to deal with that ambiguity both on a personal and organization level to prevent being limited by the choice of one.	☐	☐	☐	☒	B8 – Despite not using ambiguity, excellent coverage of concepts
Purposive Behavior: Using skills in formal operations, selects or guides the proper starting point for investigation. Uses knowledge of mental models to overcome flaws including: 1) not incorporating individual into the organization; 2) not representing the hierarchy of control; 3) relying on espoused theories vice recognizing theories in use.	☐	☐	☐	☒	B3, B8 – Excellent coverage over several elements of organization's model.
Satisficing: Understands that optimized organizations are inflexible, whereas satisficing enables dynamic boundaries and loose coupling. Knows how to decide and does so well.	☐	☐	☒	☐	A2, B4 – Model does not explicitly discuss organizational optimization and inflexibility, but does cover relationships and decision making.
Dynamic Equilibrium: Designs the system for continual self modification in the face of instability by holistically managing the constituent systems by using dynamic models.	☐	☐	☐	☒	A1, B4 – Covers most of idea in several elements of the organization's competency model.
Relaxation Time: Understands that transients impose costs on the organization. Understands the transients will have different effects at different scales, and different responses at different scales, and is able use the differences to the organizations benefit (or reduce/mitigate).	☒	☐	☐	☐	Not covered on organization's competency model.

	Grading Selection				
Section: Performance	UN	AD	VG	EX	Grade Reasoning and Comments
Self Organization: Understands social capital must not be undermined by crippling policies, but enabled by the creation and fostering of effective spaces for adaptive cooperation. These spaces must exist recursively at all levels in the organization and allow unpredictable emergent behaviors that give rise to courses of action that are different than expected.	☐	☐	☒	☐	B2, B3 – Lacks discussion of policy impact on performance.
Feedback: Develops both autopoieitic and executive controls to set targets and monitor performance and causes action to close gap between performance and goal. Uses, improves, expands workforce knowledge to achieve desired organization results.	☐	☒	☐	☐	C3, C4 – Implied in text, but specific details not present.
Requisite Variety: Enables meaning making to get more strategic thinking, collaboration, feedback, better conflict resolution, better subordinate development while redefining challenges to get higher performance with designs evolved in response to feedback.	☐	☒	☐	☐	C3, C4 – Implied in text, but specific details not present.
Control: Able to discern the boundary or limit to performance with current system and only expends the resources needed to approach that limit. Seeks out different tools/ideas/skills to jump system to a higher region with expanded limits.	☐	☐	☒	☐	C5- Partial, no discussion of new ideas needed to jump performance to a new Basin of Stability.

VITA

Dr. Bradley is an independent researcher and owner of a small business serving the defense and commercial sectors. Dr. Bradley served in a number of Naval Shipyard Department Head positions including Engineering Officer, Production Resources Officer and Operations Officer. He also served as Force Maintenance Officer at COMSUBPAC (the West Coast Submarine Type Commander), and in various Project roles, including Project Superintendent of one of the largest carrier dockings executed on the West Coast. Prior to becoming an Engineering Duty Officer, Dr. Bradley served on submarines including Engineer Officer during new construction of the USS Pennsylvania.

Since his retirement from the US Navy, Dr. Bradley has been employed as a consultant focusing on submarine conversion, Shipyard process improvement and education programs for Naval Officers. He has been employed by the US Navy specializing in submarine maintenance programs, and consulted on the development of performance measurement systems for intermediate level submarine maintenance. Throughout his working career, Dr. Bradley has either introduced or sponsored business process improvement programs to his commands and clients, including Critical Chain Project Management and Lean Six Sigma. He holds a Masters of Science in Mechanical Engineering, Professional Degree of Mechanical Engineer, a Bachelors of Engineering from The Cooper Union, is licensed professionally as Mechanical Engineer by the State of California and is both a Lean Six Sigma Black Belt and TOC Jonah.